# The Engineering Review.

Edited by

*C. EDGAR ALLEN, A.M.I.E.E., Etc.*

Vol. XIX. AUGUST, 1908. No. 2.


## SOUTH AMERICA.

FOLLOWING on the announcement that was made early in the year, we have the pleasure of presenting in the current issue a number of important contributions on the subject of the engineering position and requirements of the principal countries of South and Central America. They form, we think, some of the most instructive and interesting deliverances on the subject that have yet appeared in any periodical, and embody the conclusions of shrewd observers whose experience has qualified them, in every respect, to pronounce judgment on a matter of supreme importance to the engineering interests of this country.

Latin America is no longer lethargic; the advent of more settled conditions is leading to a rapid economic development and is providing a powerful stimulus for the promotion of trade and production. Lines of communication are being extended in all directions and the vast resources of the country offer a field for enterprise and capital that at no distant date will be eagerly snapped up. The demand for engineering appliances and material in Argentine, Mexico, Chili, and Brazil, has, during the past ten years, more than doubled, and this rate of increase will more than likely be maintained. It is true that, at the moment, the raising of cattle, cereals, sugar, the cultivation of cotton and rubber, and mining, constitute the only pursuits of any magnitude; but these are being conducted on a scale demanding the most modern machinery, apparatus and appliances. Railways, roads and bridges are also being rapidly constructed, improved or extended; harbour, river, canal and irrigation schemes are being enthusiastically undertaken; the natural water-power of the countries is being harnessed to generate electric current for the driving of mining machinery, mill and factory plant, and electric traction is making steady headway. All these developments call into requisition the skill of professional men and demand the products of the manufacturing engineer to an enormous extent, and hitherto Great Britain has enjoyed a share of this trade commensurate with her position as foremost among the industrial nations.

There are, however, facts and events so connected as to deprive them of any casual nature which point to a condition of stringency, now and in the future, in the competition for South American markets for which the past affords no parallel; and that in this, as in our home and colonial trade, invasion after invasion is being made.

American machinery and steam engines, German and Swiss electrical plant, and Belgian iron material not only visit our shores—and we are afraid under existing fiscal arrangements will still continue to do so—but are advancing in other directions in a greater ratio

than our own productions. During the ten years ending 1905, British exports to Central and South America increased by one third, those of Germany and the United States more than doubled themselves, and we are confronted with the prospect of this trade still further receding. It is not that in the most important phases of mechanical production we are behindhand, or that our electrical plant is inferior, in design or manufacture; it is rather to our fiscal shortcomings in the home, and the casual nature of our efforts and enterprise in the foreign markets, that so marked a success of the other producing nations is to be ascribed.

In the case of South America, how necessary our Consuls find it to insist that catalogues should be printed in Spanish, and that it is practically impossible to introduce, or get orders for, machinery, unless descriptions are given in the language of that country! Again, a casual glance at British Consular reports reveals the information that many important commercial districts which offer promising fields for the extension of British trade and enterprise, fall to our rivals owing to the lack of adequate representation. Few British representatives are sent to districts that are consistently scoured by properly qualified German and American travellers, who by their tact and enterprise are opening up business relations; and in other quarters, where the British have hitherto believed they held a monopoly, are securing regular and profitable custom. To take instances in Brazil and Peru:—

> In cement. Germany has practically entirely superseded British exporters, and she is steadily entering into competition in a variety of other articles once largely supplied from the United Kingdom, including rails and accessories, sewing machines, &c. . . .
>
> Port and harbour works, railway extension, building generally are all matters of certain and speedy development; and it is likely that Germany and the United States, and Belgium possibly, will furnish much of the material, unless British enterprise should prove itself equally alert in this growing field.
>
> The United States and Canadian enterprise are entering new fields in Brazil, and it is likely that the railway and electrical development of this country will largely depend on the action of North American capitalists and engineering firms.

Again:—

> In previous reports attention has been drawn to the growing importance of the trade in electrical appliances. So far all orders have been placed in the United States and Germany.
>
> Germany heads the list in iron in bar, rod, plain and sheet, and shows an increase of 425 tons, followed by Belgium, whence the increase is 599 tons. That from the United Kingdom shows a decrease of 487 tons, whilst that from Sweden and Norway shows an increase of 39 tons.

It would be easy to multiply these instances, but such self-depreciation is carried sufficiently far to justify the necessity of manufacturers putting forth their real strength, and of recognising that changes are wanted in certain branches of British industry.

Allusion is made by our special contributors to the openings which exist for the expansion of British engineering trade in South America — openings which, if properly utilised by our manufacturers, can only result in incalculable advantage to both themselves and the country at large. Indeed it is difficult to indicate lines in which there is no demand for commodities, the requirements covering practically the whole list of everything devised by human ingenuity.

Particular mention might, however, be made of electrical plant consequent upon the rapidly increasing adoption of electrical power for tramway and railway propulsion, for public and private illumination, for mill and factory drives, and for the operation of mining plant Again the shortage and miserable condition of rolling stock on many railways calls for passenger coaches and wagons of a type conformable to the varying conditions of climate or local requirements; railway construction offers openings for rails, bridge and culvert material and contractors' tools, such as shovels, picks, barrows, &c.; while farming, mining, the lumber, india-rubber and sugar industries, are the

WEST INDIA ISLANDS
CARIBBEAN SEA
NORTH
ATLANTIC
OCEAN
COLOMBIA
ECUADOR
PERU
BRAZIL
BOLIVIA
SOUTH
PACIFIC
OCEAN
ATLANTIC
OCEAN
SOUTH
Tropic of Capricorn
Falkland Islands
SOUTH AMERICA
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means of bringing about large imports of machinery used in connection therewith.

Machinery for the sugar, india-rubber and nitrate works has been largely supplied from the United Kingdom, our work in this direction being well-known and giving satisfaction. An enlarged industry is the lumber business, the principal requirements of which are the portable steam engine and saw mill. The rapid extension of internal and coastal navigation, and the construction of port works, breakwaters, quays, warehouses, depôts, calls for vessels, and plant, the supply of which by this country provides a source of satisfaction. The cotton industry is also an important one in which modern British machinery is preferred, and the motor vehicle and car would be more in evidence were it not for the deplorable condition of the roads.

The mitigating circumstance in connection with the commerce which has gone to our rivals is, that it is only in the cheaper classes of goods, lower qualities of iron, or machinery of just sufficiently light make to do the work, that we fail, the general run of plant and material of the better class being imported from the United Kingdom. We must not, however, betray that lassitude and lack of enterprise which has unhappily characterised some of our dealings in the past, or we shall see even these opportunities slip from our hands. Manufacturers must vary their standards of production to meet local requirements and views, pay strict attention to the complicated requirements of local shipping and customs regulations, and realise how necessary for the promotion of trade is advertisement—the people of South America are easily led to purchase in this manner.

In closing, allusion may be made to another matter of importance to manufacturers, viz., the British postal arrangements with Ecuador. As pointed out by Mr. Mann in his article on that country, British parcels are despatched "*via* the Straits of Magellan," a route of over 10,600 miles, occupying 85 days in transit; whereas, if despatched by the Isthmus of Panama, a distance of 5,600 miles, only 25 days would be taken.

Upon receipt of this article, THE ENGINEERING REVIEW put themselves in communication with Mr. J. Henniker Heaton, M.P., the well-known champion of Postal Reform, and he kindly agreed to raise the question in Parliament. Accordingly, on 15th ult., Mr. Henniker Heaton put the following question to the Postmaster-General, viz.:—

> Whether he was aware that the postal authorities despatched all British parcel mails for Ecuador *via* the Straits of Magellan, a route of over 10,600 miles, . . . and whether he was aware that the present arrangement gave foreigners an advantage over British manufacturers, because goods were ordered from countries where rapid transit could be ensured; and whether he proposed to take any action in the matter.

The Postmaster-General (Mr. Buxton) replied as follows:—

> All parcels from the United Kingdom for Ecuador are sent by way of France, pending the conclusion of an agreement for a direct service, as to which I have for some time been awaiting a further communication from the Government of Ecuador. The route *via* Panama is, so far as I am aware, available for parcels sent from this country to France for transmission to Ecuador; and a notification to this effect appears in the Post Office Guide. I am making inquiry of the French Administration whether any obstacle has arisen to the use of this route, and I will acquaint my hon. friend with the result.

It is satisfactory to learn that negotiations are on foot for a direct Parcel Post service between Great Britain and Ecuador, and we hope that before long this may be an established fact.

# Engineering Developments in the Argentine.

*(First Article.)*

*By A. H. ROWAN, A.M.Inst.C.E.*

In dealing with a country which stretches from the tropics of Capricorn, to close on the Antarctic Circle, a brief review can only attempt to indicate the paths which have proved attractive to capital, in which engineering developments have naturally followed. Reference to the accompanying map-memorandum, will greatly assist many readers to understand those salient characteristics of the Republic, which are a natural outcome of its physical features and climate. Reference to this map-memorandum will occur throughout this article by the letters M.M.

The area of the quadrilateral figure shown is equal to twice that of the United Kingdom. Deducting the area of water and of those portions that are shaded, which represent mountainous or fluvial districts, the remainder may be considered as one single plain devoted to raising the live stock and cereals which form the foundation of the amazing progress made by the Republic during the last ten years.

The city of Buenos Ayres, with over a million inhabitants, and a seaport of the first magnitude is, by means of the railway, the virtual living centre of this plain. Although the quadrilateral is less than one-quarter of the whole Republic, of which the total extent is indicated by the marginal annotations on the M.M., its contributes four-fifths of the exports which enrich the Republic, and it contains two-thirds of the total population, and two-thirds of the total railway mileage.

A general idea of the size of this great plain may be formed by imagining an area equal to twice that of Great Britain, in which the climate is fairly equable, with three hot summer months, but in which there is neither fuel, nor timber, nor hills, while the supply of fresh surface water is always spasmodic, and generally deficient. It is clear that such conditions are unfavourable to manufacturing on any large scale and whatever the future may bring forth in that direction the "locale" must be sought for outside the quadrilateral. This plain was eminently well suited to the well horsed Puelche savages, who before the coming of the railways in 1875-80, dominated the whole territory South of a line of frontier forts between Buenos Ayres and Villa Mercedes. It is also eminently well suited to railway making, and therefore of the greatest interest to our makers of railway material.

It is of overwhelming interest to makers of all kinds of agricultural machinery even though agricultural implements are made in the country itself. The area actually under cultivation within the quadrilateral is to-day about 38 million acres. Of this, wheat takes one-third, maize one-sixth, and lucerne one-sixth; linseed, oats, and potatoes ranking next in importance.

The most striking testimony to the potential wealth of this area is an official return of the *increase* of cultivated area during this century up to 1905 as follows:—wheat cultivation 6,060,000 acres, maize 4,292,000 acres, hay and lucerne 4,280,000, linseed 1,640,000 acres. Since 1905 the rate of increase has been equally rapid and there is no exaggeration in the statement that during this century an area

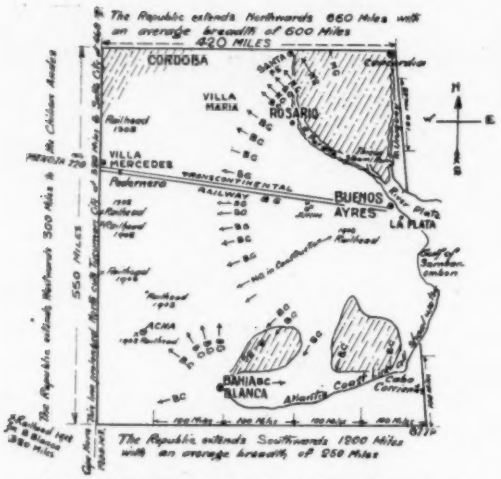



FIG. I.—MAP MEMORANDUM OF THE ARGENTINE REPUBLIC.

equal to the whole of Ireland has been put under actual cultivation.

Water-raising and distribution appliances will always find here an unlimited field.

Geologically speaking, the whole unshaded area has but recently been deposited. Over large districts the surface and subsoil waters owing to rapid evaporation are brackish, but throughout the major part of the area, fresh water from the western watershed, soaks slowly for many miles underground, and may be tapped at most places within the quadrilateral at reasonable depths.*

Owing to the absence of fuel, windmills are much used as small power water raisers. They must be solid; violent storms being common. Alcohol engines are worth attention in this field.

Cattle farming now takes rank after agriculture, and has no direct interest to the engineer, except from the point of view of refrigeration. The export of chilled beef is increasing very rapidly. In 1900 the export value was but one million dollars, to-day it is twenty millions. There are large chilling establishments at Bahia Blanca and Buenos Ayres, Rosario, Campana, and Zarate, all of which are well known on our markets.

The frozen mutton export has not increased at the same rate as that of frozen beef. It has about doubled itself within this century. The official value of exported mutton in 1905 was only £1,250,000. The official valuation of beef and mutton for export is roughly 2*d*. per lb. The wool clip is nearly all exported, but a little is now worked up in the country. A census of 1904 gives 15,000 people as employed at Buenos Ayres on the manufacture of clothing and accessories. Cotton mills which spin native cotton from the "Chaco" are worked by Argentine capital. A silk mill is in construction.

A GREAT SANTA FÉ "ESTANCIA" (Argentine).

*Estancia Rincon de San Antonio.*

| | | |
|---|---|---|
| Area ... ... ... | 260,000 acres. | |
| Under lucerne ... | 80,000 acres. | |
| Stock ... ... ... | 900,000 Durham cows. | |
| | 30,000 Hereford " | |
| | 3,600 bulls. | |
| | 10,000 sheep. | |
| Water raised daily... | 1,100,000 gallons from 64 wells. | |
| Railway stations on property ... ... | 3. | |

Eighty per cent. of the supply of labour for all purposes is derived from Italy and Northern Spain. The immigrants arrive at the rate of 150,000 to 250,000 per annum: 40,000 were landed in Buenos Ayres alone during December, 1907; of which 17,000 were Spanish and 13,000 Italians. The great landowners, the land companies, and other capitalists, also the Government itself, open up large tracts of land to form Colonies, and plant the immigrants down as soon as they arrive. Many leave the country again after a year's work. More remain and work up homes for themselves. The railways follow the Colonies at

* On the San Luis watershed, west of Villa Mercedes, the Government had to sink an artesian well to nearly 2,000 ft. before striking good water.

once, where required, with branch lines or extensions.

The great majority of the immigrants do not go beyond the quadrilateral, though within the last two years the Colonies are being pushed over the western border. Land there, which was considered arid and worthless for want of water, has been found capable of growing heavy crops of cereals and lucerne relying chiefly for moisture upon the heavy dews.

Passing now outside the quadrilateral to the north, the M.M. indicates a region of roughly 400,000 sq. miles. This region may be split into two great divisions, comprising on the east 220,000 sq. miles of relatively low plains covered with rivers, jungle, heavy timber, and swamps; and on the west 120,000 sq. miles of rugged mountainous country formed by the outlying spurs of the Andes. The whole of this region drains into the Parana. At the junction of the two divisions where the mountains merge into plain, is a fertile belt, where all sub-tropical produce can be grown with ease. Tucuman City is the centre. The position of the belt is indicated on the M.M. by the direction of the western boundary of the quadrilateral.

Tucuman is the home of a great sugar-cane industry, exporting in 1906 over 11,000 tons out of a total production of 118,000 tons of sugar. Tobacco is an important crop, and the silk industry is being developed with great energy—an official report of 1908 returns the number of mulberry trees at 11½ millions. Further north there is no striking development except the Government Railway which has reached La Quiaca, the frontier station, and is now connected with the Bolivian Railway to Tupiza. This railway has much of interest to engineers, including 6¼ miles of rack railway, where it mounts up to the great Bolivian tableland. The last section from Jujuy to La Quiaca (178 miles) cost about 1½ million sterling. The highest summit crossed is 12,290 ft. above sea level. The mines of Alto Condor in Jujuy are worked by English capital at 12,675 ft.

The mountainous region lying to the north-west of the quadrilateral contains valuable mines and the Government has there also spent large sums in constructing railways to open the country to prospectors. German capital has for years worked mines in the Famatina Sierra at 14,650 ft. with intermittent success. The mines are situated nearly 11,000 ft. above the railway station of Chilecito, but the Government has just finished 21 miles of rope tramway to serve the mining interest on the plateau.*

Passing now to the 160,000 sq. miles which lie west of the quadrilateral, that part of it lying north of the Transcontinental Railway is an arid and mountainous desert, but south of the Transcontinental Railway the great plain of the pampas continues for 150 to 200 miles before it meets the outlying range of the main Andes. At the foot of the mountains there are great possibilities for irrigation farming, as is shown by the prosperous district of Mendoza, though at present transport is wanting.

Mendoza is a widely scattered township with 30,000 inhabitants. It has great natural attractions, being a fertile oasis in an arid region, lying close under the snow-capped Andes. The fertility is entirely the result of artificial irrigation. For a hundred years, cattle from Chili have been driven across the Andes to be fattened in its lucerne pasturages, and wine of excellent quality was produced in small quantities to supply the local demand. As soon as the railway connected it with the populous centres to the east viticulture made enormous strides.

The total annual production of wine in 1905 was officially estimated at 184 million litres. Judged by the amount carried east over the railway this estimate would appear to be a conservative one. In 1906-7 the Argentine Great Western Railway carried 252,000 tons (gross) of wine, also 39,000 tons of fresh fruit and vegetables. These figures will serve to

* Cf. *Engineering*, March 20, 1908.

demonstrate the possibilities of artificial irrigation on a soil which is apparently all loose sand and salt-bush.

Passing on to the south of the quadrilateral, there lies the great area generally known as Patagonia, the lowlands of which are enclosed between a thousand miles of sea-coast on the east and a thousand miles of mountain uplands and ranges on the west.

FIG. 2.—TYPICAL DESERT (MENDOZA) WITH SALT BUSH, BEFORE IRRIGATION.

Along the coast several undeveloped natural harbours have moles to serve a regular coasting trade (in German hands). Ports Madryn and Las Piramides have narrow gauge railways of 40 and 20 miles running inland, to bridge the strip of saline desert which follows the coast line everywhere. Live stock farming is the foundation of the coasting trade, and this is chiefly in the hands of British land companies and squatters. Freezing establishments for shipping chilled beef and mutton are projected. There are very valuable salt deposits 200 miles south of Bahia Blanca which have been worked for several years, and petroleum has been struck 500 miles south of Bahia Blanca, at a depth of 1,750 ft. in tertiary strata. The Neuquen territory in the north has been opened up by a railway from Bahia Blanca as is indicated on the M.M. From the railhead there are trade roads into Chili which utilise some of the high-level lakes that constitute such a striking feature of the Andes formation south of 40° Lat. Close to the fortieth degree one chain of lakes cuts right through the Main Andes range transversely. The surface of the highest lake was officially given in 1900 as only 2,250 feet over sea level.

The drainage of this lake might be an interesting subject for speculation.

The Mount Tronador pass further south is about 3,500 feet, but is tortuous and leads nowhere at present.

It appears to be quite possible that the best part of the Argentine Republic has yet to be developed. An ideal climate, a most fertile soil, magnificent forest and mountain scenery, with endless fuel and water power; all these are claimed for the north of Patagonia by qualified observers. Colonies have failed because they were thrown out too far in advance of civilization. One bad year spelt disaster and two bad years spelt ruin. But the rapid progress of Bahia Blanca should facilitate organised settling from the western mountain side, with mixed farming; in this case a development is probable which should be full of interest to our engineering trades as many important works will follow.

A rough graphic idea of the area and temperatures of the Patagonian lowlands might be formed in this way: add another England and Scotland to the map, placing the new Great Britain due south of the old one; that would form an indented country extending from Portugal, across part of Spain, the Bay of Biscay, and part of France, up to the Orkney Islands. Substitute for our Gulf current on the west, a high chain of mountains cutting off all the moist winds from the south-west and west, and the climatic results may be estimated. Scatter where you will 50,000 human beings with some flocks of sheep and cattle in this area: then place the whole in constant connection by railway and steamer with Paris. Apologies are due to the reader for putting this strain on his imagination, but small scale maps are not stimulating; while the close conjunction of civilization and lowland solitudes on so great a scale is not only noteworthy but unique.

There seems to be no reason for this solitude now that the boundary question has been settled. The winter in the lowlands of the south is no worse than that of Denmark, a very flourishing country: and in the north the climate is better than that of Mendoza, also a very flourishing district. Certainly in the dry belt which follows all the eastern slope of the Andes, the dryness gives those sharp alterations of temperature found elsewhere on high tablelands, but so long as the mountain ranges supply fresh water in plenty the low rainfall is not *per se* a sufficient reason. Patagonia has for ages been a land of mystery, full of alleged giant Indians, escaped convicts, and snow, but all recent evidence goes to prove that the climate and the few hundred remaining Indians are equally harmless. In the Neuquen territory, where there is a marked depression in the Andes, the well-known feature of the North American "Chinook" winds is repeated on a smaller scale, and vegetation flourishes luxuriantly, the rainfall being rather excessive.

Noteworthy meteorological features are also the persistency of the south-west winds throughout the year, and the absence of thunderstorms.

## THE DEVELOPMENT OF RAILWAYS.

The railways of the Republic fall naturally into three groups of different gauges; broad, 5 ft. 6 in.; medium, 4 ft. 8½ in.; and narrow, 1 metre.

The first railway scheme to tempt foreign capital to the River Plate was that from Rosario to Cordoba, commenced in 1864. A national railway (B. A. to Chivilcoy) had been commenced in 1857, but in 1864 Rosario was the only ocean port where steamers could discharge with some comfort, and it was a most promising centre of distribution for the interior. It is amusing to note in the London prospectus, that the copper mines of Cordoba and the silver mines of San Juan (both still undiscovered) were prominent features.

But the company was floated; the impulse was given and a year or two later English capital had started the Buenos Ayres Great Southern Railway.

All the pioneer lines found the same

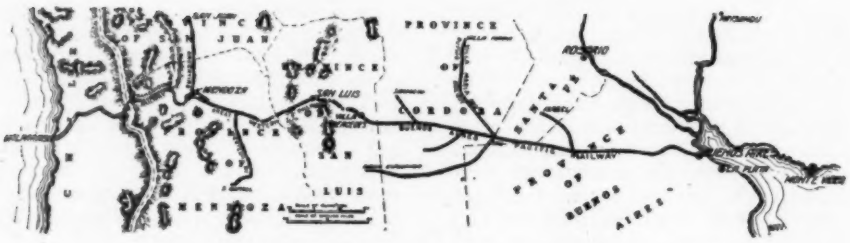



FIG. 3.—MAP SHOWING ROUTE FOLLOWED BY THE TRANS-CONTINENTAL RAILWAY.

conditions; land was valueless, curves and gradients were negligible quantities, and engineering difficulties were confined to dealing with storm water. Hence the broad gauge grew and flourished as is shown on the M.M. by the arrows indicating the existing B.G. railways, where they cut a circle of 230 miles radius from Buenos Ayres. The average space between the lines on this circle is only 32 miles. This B.G. group now includes 8,300 miles, mostly single track, capitalised at about £14,000 per mile. The whole is worked by four English companies, and sufficiently well equipped to handle traffics of from £40 to £50 per mile per week.

As a basis of comparison to the layman; Ireland with a total area of one half the *cultivated* area of the Republic has but 3,360 miles of railway, of which 661 is double track. The average traffics are £25 per mile per week. England and Wales together have 15,860 miles of railway, of which two-thirds double track, capitalised at £65,000 per mile, with average traffics of £115 per mile per week. There is clearly still room for many thousands of miles of B.G. track within the quadrilateral.

It was not long before the fertile district north of the quadrilateral also called for railways, but English capital was not tempted. The National and Provincial Governments, however, were liberalwith aid in concessions and works. Economical narrow gauge lines were thrown out north from Cordoba, and north-west from Santa Fé, to serve Tucuman; while a French company constructed light narrow gauge railways through the fertile prairies and great forests of the province of Santa Fé, until they reached as far north as Corrientes. An English company, which had joined Cordoba and Rosario by a narrow gauge line, then bought from the Government the Cordoba-Tucuman line, and is now building an extension from Rosario southwards, right into the port of Buenos Ayres. The French company, not to be outdone, has extended itself south from Rosario, and will shortly also obtain entrance for its narrow gauge lines into Buenos Ayres by means of an intermediary company.

Meanwhile the National Government had been driving hundreds of miles of economical development lines into the mountain districts which lie north-west from Cordoba, and has completed the trunk line due north from Tucuman through Salta to join the Bolivian Railway coming south from Sucre.

Thus there has gradually been formed a great narrow gauge system extending north from Buenos Ayres for 1,000 miles, with ramifications of 2,500 miles. The points where this system enters the broad gauge territory are shown on the M.M. by the letters N.G.

This system represents about £80,000,000 of capital, say, £23,000 per mile. Taken as a whole, it pays its way and leaves a surplus of profit which will be considerably increased in the near future. It is safe to assume that railway

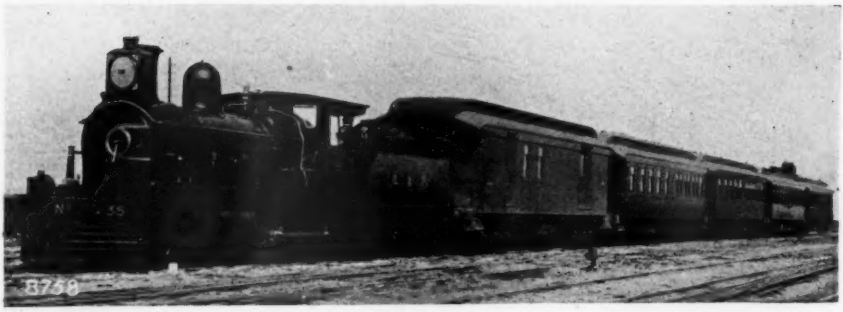


FIG. 4.—TRANSCONTINENTAL EXPRESS OF THE BUENOS AYRES AND PACIFIC RAILWAY. BROAD GAUGE.

developments north of the quadrilateral and west of the Parana will be on the metre gauge.

A medium gauge system of 4 ft. 8½ in. occupies those Eastern provinces which are cut off from the rest of the Republic by the River Parana. Until quite recently it was only represented by three comparatively unimportant local lines. To-day it reaches from the frontier of Paraguay and South Brazil to Buenos Ayres. The Parana has been bridged by means of a steam-ferry, which picks up the trains at Ibicuy (see M.M.) and deposits them at Zarate. The journey by water is forty-nine miles, and is to be done in four hours with the stream, and in four and a half hours against the stream. From Zarate the trains are hauled into Buenos Ayres by the Buenos Ayres Central Railway Co., which has taken up and relaid with 70 lb. rails the old tramway (rural) which held the right of way from Zarate to Chacarita. From Chacarita on the outskirts of Buenos Ayres electric locomotives are to haul the trains into the Plaza Once over the electric tramway metals. With the advent of the steam-ferry a new life is given to the medium gauge system. The railways of Paraguay, Uruguay, and South Brazil are all on this gauge, and it is safe to assume that the day is not far distant when other steam-ferries will get to work on the frontier rivers, and passengers and freight will pass without transfer over 600 miles from the north direct into Buenos Ayres. The infusion of capital and energy into this system is of such recent date that figures would be out of place. The capital represented is at present about £8,000,000, and the mileage open about 900.

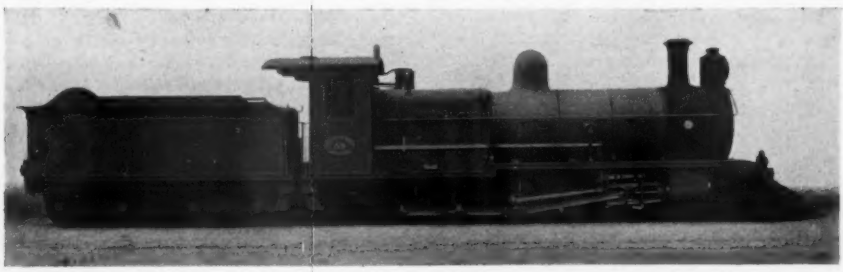


FIG. 5.—TYPE OF LOCOMOTIVE USED ON THE FERRO-CARRIL ROSARIO, BUENOS AYRES.

FIG. 6.—BOX CAR; CORDOBA CENTRAL RAILWAY.

It is hardly necessary to add that each of the large companies has very extensive workshops and complete plant for repairs and conversion of rolling stock.

**Transcontinental Railway.**—The railway indicated on the map under this name is of special interest both to engineers and South American business men.

It is nearly forty years since the original plans and surveys were made for the projected line, but it is hoped that 1911 will see the completion of the work on both sides of the Andes. From Buenos Ayres to Mendoza is 650 miles. For 360 miles the plains rise slowly from sea-level with an average slope of 2 ft. per mile. Between 360 and 500 miles the rise increases to 13 ft. per mile. Then follows 150 miles of flat depression, the rise of the whole up to Mendoza being at the rate of only 9 in. per mile. This depression is of interest, because it extends north and south for hundreds of miles, intercepting the water from the Andes which might supply the quadrilateral. As things are, the water drains south, with outfall below Bahia Blanca, and in the hot dry air is lost by evaporation in a chain of immense brackish lakes and marshes. From a railway point of view, it is a worse than useless country. From Mendoza to the entrance of the tunnel, which pierces the crest of the Andes, the distance as the crow—or condor—flies is about 70 miles. The difference of level is 7,868 ft. By constructing the railway of narrow gauge, with certain sections on the rack system, a practicable line has been found with only 50 per cent. elongation. The tunnel has a length of 5,600 ft. in the Argentine. The length in Chili is 4,300 ft.*

The Argentine portion of the Transcontinental Railway is owned by three separate companies; the narrow gauge and rack railway section from the Chilian boundary as far as Mendoza belongs to the Transandine Railway Co., the section (B.G.) from Mendoza to Villa Mercedes is a part of the Argentine Great Western Railway, and from Villa Mercedes to Buenos Ayres port is the property of the Buenos Ayres and Pacific Railway Co. The latter company by arrangement works the whole.

### THE DEVELOPMENT OF PORTS.

The four principal ports of the Republic are, Buenos Ayres, Rosario, La

* For the continuation of this railway to Valparaiso see article on Chilian Railways.

Plata and Bahia Blanca. There are a number of other minor ports on the River Parana, of which Sta. Fé is the principal, and there are a few harbours on the Patagonian Coast.

In 1906 Buenos Ayres handled 70 per cent. of the exports and 86 per cent. of the imports of the whole country, with a value of £89,000,000—the total oversea tonnage being 4,490,000—entries and departures.

The port has for the last ten years been equipped with every modern convenience: warehouses, grain elevators, floating, stationary, and travelling cranes, &c.

The Government docks, which can berth steamers up to 24 ft. draught, are built along the river frontage close to the centre of the city, on foundations cut out of the river bed, and are surrounded by land reclaimed from the river. They are approached from the open roadstead by two channels, also excavated in the river bed; these extend about 10 miles from the docks into the open roadstead and are easily kept open by dredging.

One channel enters a south basin of 35 acres, the other a north basin of 41 acres. The distance between the two entrances is 3½ miles. Between the two basins are four docks which average 25 acres each. The whole offers nearly 5½ miles of berthing accommodation, with 1½ miles of warehouses. There are two graving docks.

The docks are cut off from the estuary waters by 3¾ miles of sea wall. Nine hundred and twenty-six acres were thus reclaimed from the river and the value of the surplus reclaimed land, nearly a million square yards, has helped to recoup the Government the £7,000,000 spent on the work. The Government valuation in 1900 of this land was £11 per square yard. Notwithstanding the liberal allowance made for the increase of trade when planning the docks, the accommodation offered is often far too small.

In consequence the Buenos Ayres Great Southern Railway has promoted and constructed, South of the Riachuelo, a large new dock, while the three railway companies coming in from the west and north, viz., the Buenos Ayres and Pacific (Transcontinental), the Buenos Ayres and Rosario Railway, and the Central, Cordoba (narrow gauge from Tucuman), conjointly with the Government, have commenced the works for building new docks and terminal conveniences on land reclaimed from the river to the North of the Government docks, opposite the Retiro Station. When these are completed there will be about 6 miles of port frontage. An overhead railway is planned to take passengers in from the Retiro to the centre (Calle Cangallo), while 7 miles of double track electric tramway will be opened this year connecting up the old Riachuelo warehouses and the south dock with the new docks and stations at the Retiro.

**Rosario.**—The river Parana gives access to this port at all seasons for ocean going steamers under 21 ft. draught. The National Government keeps a river channel dredged and lighted so that steamers can now pass by night without delay through the mud banks whenever the water enables them to get through the Martin Garcia channel at the entrance of the river Parana into the river Plate.

In 1902 a concession was granted to a French company to construct an up-to-date well-equipped port. This is now well on towards completion, with

FIG. 7.—TYPICAL GRAIN WAGON. B. A. P. RAILWAY.

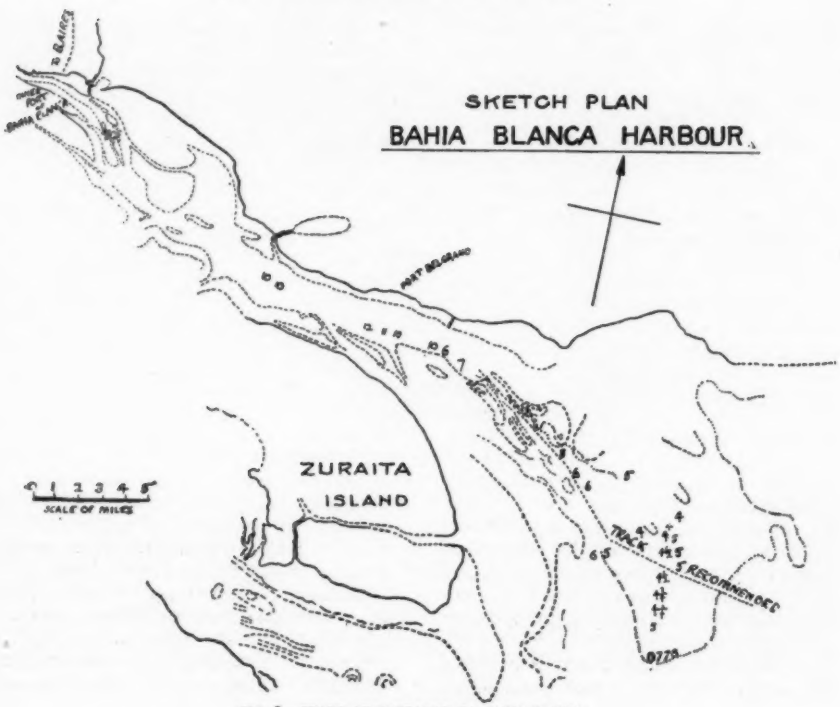



FIG. 8.—CHART OF ENTRANCE TO BAHIA BLANCA.

about 1½ miles of accommodation. The railway companies have purchased land and placed their own quays, grain elevators, and other accommodation, to the north of the French docks.

Exports are valued at from eight to ten millions sterling per annum, but fluctuate considerably with the wheat and maize crops, which form 80 per cent. of the traffic. At Santa Fé (Colastiné) a new channel has been opened and ocean going steamers can load there up to 19 ft. draught.

**La Plata,** 35 miles south-east from Buenos Ayres, is the capital of the province of Buenos Ayres. It does an extensive coasting and fluvial business, and is used a good deal by the minor ocean traffic, in favourable weather and tides.

**Bahia Blanca.** — A glance at the M.M. will show that a port at Bahia Blanca will have many advantages. The distance from Pedernera Junction on the transcontinental line to Bahia Blanca is rather less than the distance to Buenos Ayres. A well constructed broad gauge railway with 100 lb. rails now connects Pedernera Junction and Bahia Blanca. It will be seen, therefore, that a port at Bahia Blanca will have a monopoly of the as yet unopened territory south and west of the quadrilateral besides serving a large slice of the already opened country south of the Transcontinental Railway. The national dockyards are placed here as is shown on the plan, the official name being Port Belgrano. This port is a natural deep-water harbour, well protected from easterly gales. The new docks in construction by the railways are in the shallower water at the end of the bay, about 40 miles from the deep-sea

entrance (see plans). The mean tide is given as 14 ft., and the maximum 18 ft. There seems to be no reason why the largest steamers should not eventually pass up to the railway docks. Several suction dredgers are at work excavating a 30-ft. deep channel and reclaiming the foreshore. The railway companies meantime provide well equipped moles with elevators and everything necessary to accommodate sixteen seagoing steamers of draught not exceeding 25 ft. A million tons of wheat were handled in 1905.

The town is increasing annually by 10,000 to 15,000 inhabitants. Gas and water supply is provided. An electric light and power station with a tramway system, now being converted to electric power, has been built by the Buenos Ayres and Pacific Railway. A drainage scheme is under consideration.

FIG. 9.—E. R. R. CO. STEAM FERRY (1908) IN DOCK SHOWING LOCOMOTIVE AND TRAIN COMING ON TO HINGE BRIDGE.

### TRAMWAYS.

Buenos Ayres has been well known to travellers for many years as the city with a tram in every street. As the streets are not wide a double track is forced to occupy two streets, and as street making is very expensive tramway companies have helped the municipality to cover a multitude of sins. The total network is about 340 miles of track, all of which is now worked by electric power. This really means something under 200 miles of tramway route, which is not large for a district of over 1,100,000 inhabitants, covering 72 sq. miles. There will be rapid development in the near future, as the outskirts of the municipal district are being built over very rapidly, and the Belgians, whose experience in tramway management is unequalled, are gradually obtaining the working control of all the old network. New ground has been broken outside the municipal boundaries by the Lacroze Tramway Co. to the west, and to the south by the Tramways Sud, an Argentine enterprise. All the old tramways, say 300 miles, have to purchase their power from a central station, owned by the German Transatlantic Electrical Co., which has so far had a monopoly of current supply, having secured a contract for the public lighting of the capital until 1957. At that date the station may pass into municipal hands. The central station has an output of over 12,000 h.p. The cost of power per car-mile is double the cost of power in London, and four times the cost of power in Glasgow, but it must be remembered that coal costs 35*s.* per ton and that the length of track is great.

The Lacroze Tramway Co. has, however, built an independent generating station to work the 56 miles of tramway which it will complete this year. This company is of special interest to engineers, not only as being the first in the city to set up an independent electrical

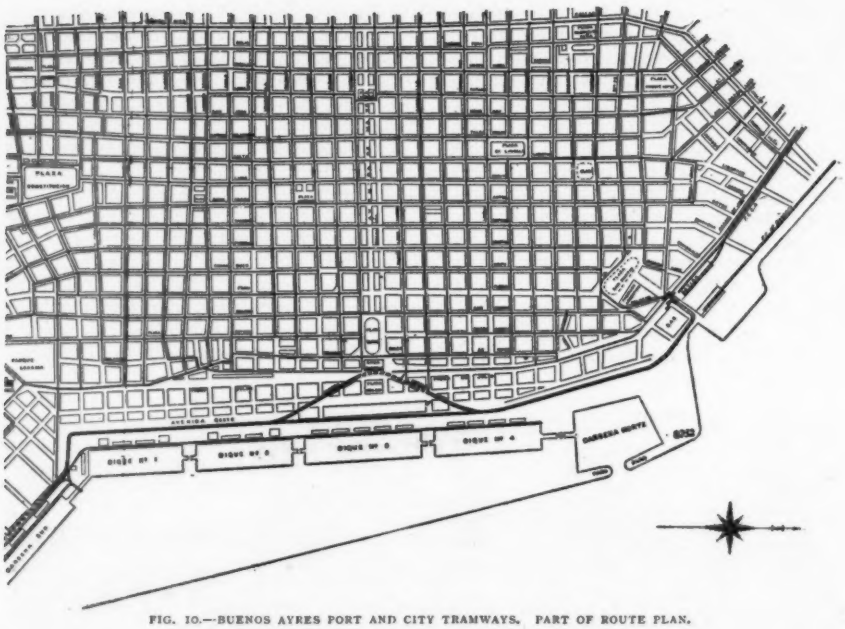


FIG. 10.—BUENOS AYRES PORT AND CITY TRAMWAYS. PART OF ROUTE PLAN.

existence, but also because it will act as the channel by which it is proposed to give the 4 ft. 8½ in. gauge railway system entrance into the centre of the city.

The combination thus arising of steam and electrical haulage gives rise to conditions interesting to the engineer.

Another scheme of importance is on the point of being completed by the Buenos Ayres Port and Tramways Co. The object of this line is to distribute passengers and goods along the whole port frontage from the Riachuelo to the Retiro. This requires 7 miles of double track, and has many special points of interest.

In the provinces most of the towns have tramways, which may aggregate some 250 miles, of which about 100 are worked or to be worked by electric power. The most important is that of Rosario, in Belgian hands. The La Plata system will, when converted to electric power, be of equal or greater importance. There is some hope that it may remain in British hands, as the lighting station is owned by a British company.

## ROADS.

Like other new countries the Argentine Republic is deficient in this respect. Since there is neither timber nor stone on the great plains, railways can be built cheaper than roads. As a rule the weather is dry, and traffic passes anywhere in the bullock-cart, but one rain storm may upset communications for days. There is an enormous field open for portable and agricultural rail tracks. The development of motor cars appears to have brought the road question into prominence of late. Congress sanctioned a law last autumn by which 3 per cent. of the net receipts of the railway companies is to be handed over to Government and ear-marked for a road-building fund. Motor cars as luxuries are common, but, owing to the cost

of fuel, motor-traction as commercial enterprise has not very bright prospects.

Petroleum has been found in several localities, but was soon exhausted. Alcohol might, however, be manufactured *ad libitum* in the country, and be used for engine power.

All the old difficulties of surface gradients and boiler maintenance in a new country militate against steam, but should a petroleum field be opened makers of steam tractors with petroleum fuel would have prospects. There were only 881 motor vehicles registered in Buenos Ayres city last year, of which not more than 155 were commercial vehicles, including a few motor omnibuses. The import dues on petrol, and defective roads, explain the limitation.

**MINING.**

There has never been any real development of mineral industry within the Republic. During the last three or four years, since the railways have been pushed into the interior, prospecting and exploration have found substantial support, and at several distant points works are commenced on a scientific and commercial basis. Mining companies have been registered in London, and several of importance have been formed in Buenos Ayres. Thousands of claims have been registered at the Mines Department in the last two or three years. Capital and speculation are both plentiful in the Republic, but the prospects must be very good indeed which will tempt them away from the farming and live stock industries. Land speculation on the plains is just as exciting and much safer and easier than metal hunting in desolate mountain ranges.

Coming to facts, rich copper ore containing gold and silver is mined and smelted successfully in Rioja, some 300 miles north-west from Cordoba. English capital took over the well-known "Mejicana" group in 1903, and smelters are now at work. Valuable borax deposits are worked 500 miles north of Cordoba. Placer gold has been won in the Andes west of Bahia Blanca and in San Juan, 150 miles north of Mendoza. Fairly good coal is being got out of a pocket at Salagasta, 10 miles from Mendoza. Salt deposits 200 miles south of Bahia Blanca are very profitable; and other deposits on the Pampas are worked. Onyx and malachite are mined successfully west of Villa Mercedes.

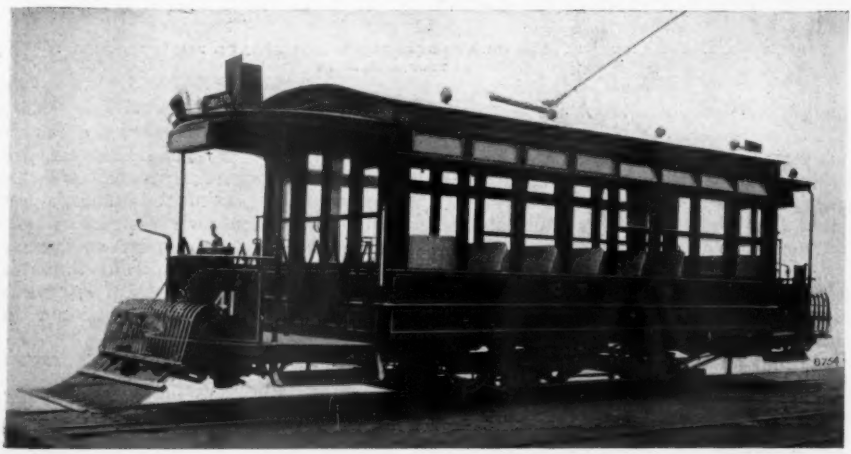



FIG. 11.—TRAMCAR (1908). CONVERTIBLE WINTER OR SUMMER CAR (DICK KERR AND CO., LTD.)

The exports of mineral from the Republic have remained constant and trivial for the last ten years, but it is quite possible for a good deal of mineral to pass into Chili without appearing in Argentine records. The exports consist principally of borax and "matte."

### WATERWORKS AND DRAINAGE.

The supply of water for Buenos Ayres is taken from the River Plate. The method by which the distribution head for the three different levels of the original service was completed by the Government in 1895 on a basis of 20,000,000 galls. per diem, but the pumping power has since been increased to 37,000,000 galls. A drainage system was naturally created at the same time. It was opened in 1891 with outfall at Quilmes 12 miles lower down the river. As the population has more than doubled itself since 1895 and is increasing annually at a corresponding ratio, it is evident there is still much work to be done in these directions within the Federal district.

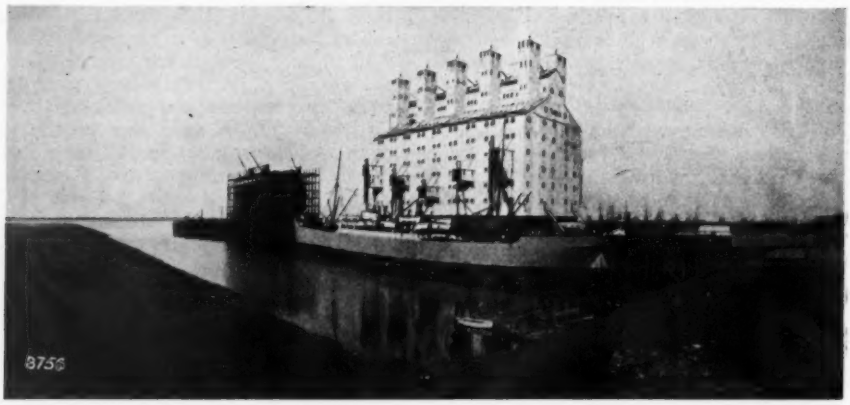


FIG. 12.—B. A. G. S. RAILWAY CO. ELEVATORS AT BAHIA BLANCA SHOWING 25 FT. DRAUGHT STEAMER IN ONE OF THE TEMPORARY DOCKS.

town has been obtained is noteworthy. Three reservoirs are placed one above the other in one central building, the highest reservoir being 74 ft. above the ground level. Each reservoir is divided into four units which hold about 5,000,000 galls.

The ironwork alone in this building amounted to 16,000 tons. Municipal statistics for December, 1907, give the number of houses supplied as 62,500 and the amount of water used as 4,416,000 kils. This, if correct, would be equal to 30 galls. per head per diem for the whole Federal district. The water-carrier, however, still follows his profession in some quarters. The

### WATERWAYS.

The great waterways of the Parana and Uruguay enable ocean coasting steamers to penetrate inland as far as the northern line of the quadrilateral, while from thence river steamers open up the Parana to the northern frontier. Thus it may well be said that the Republic has 2,400 miles of coast line, but no waterways. The want is noteworthy.

The coasting and fluvial traffic reaches very large figures, officially returned in 1905 at 17,000,000 tons, but the position of the Parana as a high road for traffic is analogous to that of the Thames and Clyde, which destroyed

the passenger traffic on those rivers. The traffic cannot reach the river, and seeks the more convenient parallel metal roads. That position can, and no doubt will, be improved in time, by canals across the low-lying, water-filled country which shuts in the great riverway along the greater part of its passage through the Republic.

**HYDRO-ELECTRIC INSTALLATION.**

So far there is only one in the Republic. This is on the Rio Primero, about 20 miles from Cordoba. The current generated is used to light that provincial capital and for the manufacture of carbide of calcium. Acetylene gas is being applied in a great many directions. The supply of limestone is excellent and unlimited, but the carbon has to be imported at a heavy cost.

Space does not permit a description of several important projects which promise to be realised in the near future, but the following should be mentioned:

Underground electric tubes in the capital. There are three schemes before Congress.

Extension of Buenos Ayres Port. The Government is authorised to spend a further three millions sterling on additions and improvements, of which three-quarters of a million on railway connections and facilities.

A railway is authorised from Villa Mercedes (see M.M.) to Port San Antonio, in the Gulf of San Matias, some 200 miles south of Bahia Blanca; length about 550 miles.

A railway from Cordoba running south to Rio Cuarto, 132 miles; estimated cost, £1,056,000.

Industrial railways. An Argentine association projects a network of light railways at £1,500 to £2,000 per mile to act as feeders to the main railways on the plains.

Canals to open up the Parana.

Petroleum field in Santa Cruz territory to be prospected and developed.

A new group of railways in the Southern Territories to be studied and constructed by the State.

*A New Port in Samborombon Gulf.*—A concession for 99 years was granted in 1902 by the National Government with a contingent subvention, for the creation of a 30 ft. port near the outfall of the River Salado. This is the only part of the coast where the 6-fathom line comes close in to the shore line, but the gulf is open to easterly gales. The scheme has been favourably reported upon by an eminent American engineer, who relies upon the Eastern Bank as a protection. A company has been registered to carry out the work, subject to the passing of a Bill now before the Congress, for the granting of increased national facilities to the company.

**CONCLUSION.**

In conclusion, if this brief outline of facts is to assist in any practical deduction, it must be remembered that in another decade the Republic will be producing within itself every necessary of life except coal and iron: nor can it be reiterated too often, firstly, that there is no place on the face of the earth more cosmopolitan than Buenos Ayres; secondly, that the British are numerically but an insignificant fraction in a Latin population, becoming denser every year.

We hold, most undoubtedly, a splendid position in the public works of the quadrilateral. That position is limited in time. It owes its existence largely to the past generation, who took their risks as "ranchers" and railway builders, and identified their personal interests with those of the country in which they lived. We shall continue to hold that position for many years, by our influence as a commercial nation which handles 35 per cent. of the exterior trade of the Republic; and by the power of our monopolies as public carriers of a great share of the inland trade, but it may be doubted whether we have improved our position as factors in the internal life of the nation. The engineering trades of our competitors are keen and clever and well organised, and they have succeeded, in many cases, in building up a position on the foundations which we laid, our own enterprise being

at present just equal to helping them to find the money wherewith to build. Not large sums perhaps; mere straws in the great trade-winds of commerce, but straws have a function. The British immigration in 1906 numbered 1,600—less than 1 per cent. of the whole—and a consular report tells us curtly, "British immigrants do not suit this country." If not, why not? British immigrants do very well in North America, why not in South America?

Let it be granted that the hot inland regions of the north and west, with their cultures of wine, and silk, and tobacco, and cotton, are better suited to a southern race than to ours. Let it be granted that our average immigrant does not shine as an agricultural labourer on the great plains among Italian or Basque husbandmen. Let it be granted that in a great Latin capital we have certain disadvantages. Surely all these are but reasons which might induce a wise foresight and organisation to colonise that great southern region which has none of these drawbacks, and thereby help to retain our old place in the progress of the Republic, instead of being "squeezed out." Patagonia lies there, desolate and uninhabited, open to any who will take possession under the "ægis" of a friendly and sympathetic Government. But it is a case that requires a treatment which might be most briefly described as "Canadian." That name infers surveyed territories, indisputable ownership, and small allotments of the land at a nominal price to all who will farm it. Under these conditions scores of thousands of British emigrants to North America become every year prosperous, hardy, law-abiding citizens, such as may be found to-day in Patagonia itself, in the Argentine descendants of the old Welsh colony of Chubut. If in North America, why not in South America? It would be interesting to know the official reasons for the warning to British emigrants against a country in which all other nationalities succeed.

# The Argentine Republic.

*(Second Article.)*

*By ROBERT H. REID.*

AMONGST the various Central and South American Republics, no one during the past ten or twelve years has displayed such colossal economic and commercial development as Argentine. With its vast territory—extending to 800,000 sq. kilometres—there is ample scope for every class of modern enterprise and achievement. To provide for the necessities of the fruits of its soil, it already proudly stands at the head of all the South and Central American Republics in the matter of railways, possessing between 22,000 and 23,000 kilometres of State and other lines, by far the greatest extent of the latter being British owned. Although chiefly a pastoral and agricultural country, the manipulations of which do not particularly come under the scope of this article, perhaps these have tended in a great measure to develop the engineering industries which are to be found to-day within the confines of the Republic—engineering appliances to cultivate the land or thrash the crops, irrigation undertakings to assist in some districts in making barren soil yield the golden grain, and freezing establishments to preserve the meat, and locomotives and steamers to convey the

harvests and meat to the markets of the world.

As an evidence that Argentine may be justly considered one of the most important agricultural centres of the world, we may here mention that the extent of land sown last year in different zones embraced an area of 70 million hectares, yielding a crop of wheat, linseed and oats, of nearly seven million tons, about six million tons of which were for export.

Most of the results of this immense progress and prosperity filter towards the federal capital (Buenos Aires), Rosario and Bahia Blanca. Therefore it is in these three places where we find the greatest evidences of engineering development. Of course, it is in the port of the capital where we see the most colossal progress. Where within the memory of the present generation all cargoes from and to beached vessels or steamers had to be landed by means of carts drawn by bullocks or horses, magnificent docks and darsenas have been constructed, with all the latest engineering, hydraulic or other modern appliances, enabling large steamers to land their passengers right on spacious embankments and cargoes to be discharged into railway trucks.

## RAILWAYS.

Looking at the latest map of the railways just issued by the Government, the lines spread out from Buenos Aires to the most fertile parts of the Republic like the spokes of a wheel. The different railways are as under :—

*Narrow Gauge* (one metre).—Central Northern (State Railway), North Argentine, Provincial Santa Fé, Cordoba Central (North and Eastern section and extension to Buenos Aires), Argentine North-Western, Cordoba and Rosario, Cordoba and North-Western Transandine and Chubut Central.

*Medium Gauge* (1·435 m.)—Santo Tomé to Posadas (State), East Argentine, Argentine North-Eastern, Entre Rios, Rural (now Buenos Aires Central).

*Broad Gauge* (1·676 m.)—Andine (State), Great Southern, Buenos Aires Western, Buenos Aires and Rosario, Central Argentine, Buenos Aires Pacific, Argentine Great Western, Bahia Blanca and North-Western, and Rosario to Belgrano Port Railway.

When the railways were initiated in 1857 the total longitude was ten km. while at the end of 1897 that had increased to 15,219 and at the end of 1907 to about 22,000 km.

The capital invested increased from $283,108 in 1857 to $650,776,101 in 1906.

While there are very few engineering difficulties in Argentine compared with Chili and Peru, except towards Cordoba, the various companies continue to add to the mileage of their present lines, or make branches. The Buenos Aires has at present in construction, or projected, an extent of 2,279 km. Its viaduct, which will give an independent entrance to the heart of the city, is nearly terminated from Calle Rivera to the river, crossing the line of the Rosario railways at Calle Tangle. The splendid iron bridge terminates at the river embankment, where the Pacific is also filling in land for the purpose of constructing a large cargo station, sidings and depôts. The defence work along the river up to the present embraces an extension of 2,500 lineal metres, and the walls protecting the water opposite Calle Tangle and the North Darsena will be united in a very short time.

The Southern Railway Company has likewise been recently making great improvements and additions within a short radius of their central station in the city. It has nearly finished the work of embellishing the Constitucion station, thus giving not only greatly increased accommodation to the passengers, but enlarging the various offices. To avoid the continuous danger to people having to traverse the many level crossings between Plaza Constitucion and Kilometre 5, the Southern has converted its rails to a high level as far as Calle Australia, afterwards with a stonework viaduct till reaching Valle Villareno, following subsequently with a high terraplane till passing Calle Pavon, where it commences to descend to unite with the existing lines at Kilometre 5. One of the two bridges over the River Riachuelo is finished and the other is being rapidly proceeded with. They

are each thirty metres in length on the Scherzer principle, with a space of thirty-three metres wide for vessels to pass through.

The Southern is just now completing a number of branch lines, the chief one being between the stations Gardey and Cooper. At various stations the Southern is forming colonies for its employees, the most important being at the workshops Los Talleres, near Banfield, where there has been erected ninety dwelling houses. Other colonies for engine drivers and firemen are proposed to be formed between Bahia Blanca and Ingeniere White, where it is proposed to construct also ample accommodation for workshops, depots for locomotives and general stores.

At La Plata the station recently constructed has been found to be too small for the amount of traffic, and it is proposed to enlarge it considerably. Some time ago the Southern rented the property of the Compania Muelles y Depositos de La Plata, and in order to take every advantage of this concession, it is proposed to put down a line to connect the property with the line to Ensenada.

### RAILWAY FERRY BOATS.

The Entre Rios Railway Company recently constructed a large ferry steamer, which plies on the River Paraná between Ibicuy and Zaraté, greatly expediting the service on that line. At present only goods trains are carried over on the steamer; but this has been so very successful that the passenger service will be added in a very short time. The berthing of the boats in the ferry slips at the two ports is done with much ease, while the drops and aprons, which are adjustable to allow for the variations in the depth of the river, work satisfactorily. This ferry steamer immensely shortens the run from Entre Rios to the Federal capital.

### ANOTHER PRIVATE RAILWAY.

Another private railway is about to be constructed, of which Mr. E. Carrasco is the concessionary. On April 29th the President of the Republic signed the contract for the construction of a railway from the valley of Lerma to Hautiquina. According to that contract the constructor will receive from the Government a subvention of $3,000,000 gold, which will be paid in fractions upon presentation of certificates of the value of the work done.

### GRAIN ELEVATORS AT STATIONS.

The expeditious handling of wheat after every harvest in this country is such a great desideratum that in order to cope with the yearly demands a company has been formed, entitled the Argentine Grain Elevator Company, Ltd. It has been recently granted the right to erect thirty-two grain elevators on ground adjoining a similar number of stations on the Southern Railway. The minimum capacity of each elevator must be 1,000 tons. The company has its head offices at 32, Queen Victoria Street, London.

### PROJECTED UNDERGROUND RAILWAYS.

The general cart and carriage traffic along with the movement by tramways of the million inhabitants within the city boundary through its narrow streets during the past few years have caused frequent blocks and delays, to remedy which various remedies have been proposed by the municipality. Amongst these the authorities recently decided to limit the hours of the unloading and loading carts in the centre of the city; but this is generally looked upon as a poor makeshift only, and the real remedy is only to be found in the construction of several underground electric railways. This is not the first time this matter has been on the *tapis*; but two years ago all concessions granted for the construction of underground electric railways lapsed in consequence of no work having been initiated within the time stipulated by the Government.

Again, however, this important engineering work has occupied the attention of the City Fathers, and the municipality recently called for tenders

in London, Paris, Berlin, Brussels, Rome, and New York, for the construction of two of the lines of underground electric railways.

### ELECTRIC TRAMWAYS.

Nine tramway companies attend to the service of passenger traffic through the city and its surroundings, these being Anglo-Argentino, Buenos Aires and Belgrano, La Capital, Metropolitano, Buenos Aires, Gran Nacional, Belga-Argentina, Electrico del Sur, and Compania Lacroze.

By a law dated October 26th, 1868, the first tramway was authorised in the Federal capital, the first cars being run by Messrs. Lacroze.

At first the carriages were all drawn by horses, but gradually electricity was adopted as the motive power, and for more than a year all the nine companies have been electrically worked.

In 1905 the different tramways had an extension of 484 km., of which 149 km. were worked by horses and 335 km. by electricity. During the past two years the lines have been considerably extended, particularly that of Lacroze Company, to Saavedra and the town of San Martin, and another company to Quilmes.

But one of the greatest extensions in the electrical system of the city is just about to be inaugurated by the new Port Tramways Company, which has its London offices at 2, Broad Street Place, E.C. The line runs along the whole length of the docks of the city from Barracas Bridge to Retiro Railway Station.

Already twenty-four cars of the latest "Preston" type, built by Messrs. Dick, Kerr & Co., are in readiness for the inauguration on May 1st. The same firm also built the motors.

A new feature in the service of the new company will be the transport of coal and other merchandise by tramcar. Of course, specially constructed cars and wagons will be used for this purpose.

It may be mentioned that this new enterprise is thoroughly British-formed with British capital, whilst the line was constructed by English contractors, Messrs. Lowther & Co.

The following are the principal electric power companies in the city:—

Alemana Trasatlantica de Electricidad.—Registered in 1898. It has three power stations: (1) Three-wire system with bare neutral, continuous, capacity 8,000 h.p., pressure on the outers is 440 volts; (2) system, alternating and triphase, capacity 7,000 h.p.; (3) alternating system, 3,400 volts, capacity 1,500 h.p. This company also supplies current to some of the tramway companies.

Bright's Light and Power, Limited.—This company has the exclusive monopoly of all public lighting for twenty-five years from May, 1898. The total capacity of the plant is 140 kw. At Santiago del Estero station the system is alternating at 2,000 volts, transforming to 100 volts. The Salta station has a capacity of 200 kw., the system being three-wire, 440 volts.

The above were the original figures, but since both these companies were established they have made great additions to their plant according to the growing requirements of the city.

### THE PORTS OF THE REPUBLIC.

Amongst the many ports in the rivers and on the Atlantic side of Argentine are Buenos Aires, in the River Plate; Rosario, in the River Paraná; and Bahia Blanca, on the Atlantic coast. The port of Buenos Aires possesses two entrance channels; one is part of Riachuelo (the original port of the town), named the South, and the other, the North Darsena, having a breadth of 100 metres and a depth of 21 ft. Between the North and South Darsena there are four docks: No. 1, with a dimension of 570 metres in length by 160 in breadth; Nos. 2 and 3, measuring 690 by 160 metres each; and No. 4, which is in communication with the North Darsena, is 630 metres long by 160 in width. The movement of the cranes, bridges, locks, capstans, &c., is worked by hydraulic power from two stations, one at No. 1 Dock and the other at the Boca.

Notwithstanding the apparent enormous capacity of the port of Buenos Aires, it has been found during the past

two or three years that the Republic has made such gigantic progress and the intercommunication by sea with other nations has become so great, that the port facilities and accommodation are altogether inadequate. Without counting the sailing vessels, of which there are a large number engaged in the coasting trade, the total number of steamers which annually on an average visit this port is over 3,000, with a united tonnage of seven millions. For some time shipowners and merchants alike have been put to great loss and inconvenience by the long delays in discharging and loading of cargo, owing to the continual congested state of the port, often steamers lying along the moles three and four deep.

There is a probability that this state of matters will shortly be remedied. The Government is actually studying various projects for enlarging and improving the port, and several leading engineers have been consulted with reference to this important matter.

In carrying out this project it is proposed that the docks should have one side devoted to import goods and another to exports, thus facilitating the discharging and loading of merchandise. It also provides that the depots will be able to receive the complete cargo of a steamer without being shifted. Between the depots there will be constructed sheds under which the trains can run with freight, thereby protecting goods from the rain, and enabling work to be carried on in all weathers.

Amongst the different erections about the port there are some notable buildings on the east side of Dock No. 3, which, perhaps, have not their equal in any part of the world. We refer to the grain elevators and flour mills belonging to the Belgian Company "Sociedad de Molinos Hareneros y Elevadores de Granos." The first two flour mills combined dealt with 500 tons of wheat daily, with a production of 5,000 sacks of flour of 70 kilos. each; but, large as these were, it was found that their output was not sufficient to satisfy the demand. The installation was completed therefor by the addition of other mills, fixing the capacity at 600 tons of wheat per day, with a production of 7,000 bags of flour of 70 kilos. each; and to-day we see working near the side of No. 3 Dock the largest flour mill in South America, if not in the world.

Everything is carried out by the latest improved systems and with the most perfect machinery, all completely automatic, even to the sterilising of the grain before it is ground; 3,500 h.p. is necessary to drive the machinery of the mills.

The grain elevators are able to discharge the grain from a long string of wagons and simultaneously load six steamers at the mole.

Their principal characteristics are: Capacity to discharge 500 tons of grain in bulk per hour, or 6,000 tons per day of twelve hours; and capacity of loading, 300 tons per hour, or 3,600 tons per day of twelve hours.

The following is the capacity of the granary cellars: 38 bins with a capacity of 550 tons each; 43 with a capacity of 125 tons each; 19 with a capacity of 75 tons each; and 17 with a capacity of 150 tons each—total capacity of the 117 bins, 30,000 tons. Capacity of the granary depots—depots central, north and south, 70,000 tons.

Thus the total capacity of the Rio de la Plata elevators is 100,000 tons.

The amplification of the port of Rosario, which should have been finished last October, will probably—owing to the difficulties which have occurred—not be finished for the next two years. This unfinished part embraces the section from the Cordoba and Rosario Railway (Puerto Canals) to the union with the national mole.

A project has been submitted for still further improving that port. This consists in constructing new moles and depots for produce of the Republic destined for exportation. The projected works were estimated to cost $3,500,000 gold.

The commission entrusted with the care of the lower portion of the River Paraná has just sent to the direction of

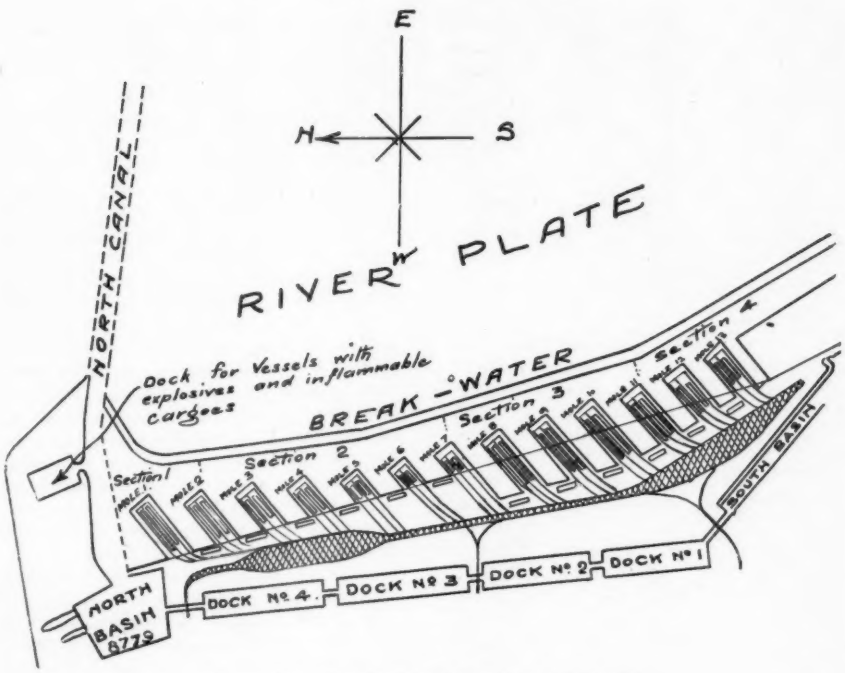



FIG. 1.—PROJECT FOR ENLARGING THE PORT OF BUENOS AYRES.

hydraulic works its report corresponding to the work done during the year 1907. This report states that during last year the commission succeeded in dredging 1,687,000 cubic metres of sand, by which it obtained a minimum depth of 21 ft. at the entrance of the port of Rosario and 15 ft. up to the port of Colastiné. Since 1903 the dredging of the river has increased, the depth at Rosario from 15 ft. to 21 ft. and at Colastiné from 10 ft. to 13 ft. 6 in.

Amongst other public projects by the Government is the amplification of the port of Quequen, on the coast to the south of the province of Buenos Aires.

Work has also been commenced at the port of Paraná, in the construction of a section for foreign exports and imports. The projected work consists of 200 metres of a mole for exports and a similar mole for imports, provided with four electrically-driven winches, and another mole of 200 metres in length for handling coast produce. The work is estimated to cost $1.597,000.

The port of Concordia, in the province of Entre Rios, will very shortly be one of the most important centres of that littoral, as recently there has been executed some important works there. Already the work completed gives ample facilities for the loading and discharging of vessels, the mole having different heights enabling operations to be carried on when the water in the river is from 6 metres to 10·50 metres in depth.

The Government is regularly acquiring the necessary dredging materials in order to maintain a depth in the channels of the River Paraná of 20 ft. as far up as Santa Fé and Colastiné at all seasons of the year. When once the additions

to the port of Santa Fé have been finished, this will not only be the place for embarking the produce of this large agricultural zone, but will be the centre for the arrival and departure of traffic connected with the north of the Republic and even with Bolivia.

The Pacific Railway Company has for some time been actively prosecuting the work of extending the port of Galván, where it has a concession to construct 6,000 metres of a mole, a considerable part of which is already finished.

Then again, the Great Southern Railway Co. have just completed the erection of a new steel elevator mole at Ingeniero White, port of Bahia Blanca. The mole has a length of 1,132 ft. and a width of 132 ft., carrying six lines of rails. At present there is a depth of 25 ft. below low water, which depth will shortly be increased to 30 ft., and at high tide there is a depth of 37 ft. On the mole are two grain elevator buildings, each 185 ft. long by 88 ft. wide, and each having storage capacity for 13,000 tons of grain. In each building there are ten elevators capable of raising grain at the rate of 150 tons per hour each. In addition, there are four sack elevators in each building. Ships can be berthed on either side of the mole, so that the two elevators can deal with four steamers berthed alongside, and the loading-out shoots for grain are designed so that they can also load ships on the second berth, accommodation being thus provided for eight steamers at a time, if necessary. All elevating work is done by electric power supplied from the company's power station.

### IRRIGATION WORKS.

The Government have been very anxious to carry out the work of irrigation in many of the provinces, but in recent years the most notable work of this nature has been the completion of the irrigation works of Villa Mercedes (San Luis). We refer especially to that part referring to the dam and the principal and secondary canals. These were finished in November, 1905, consisting of a dam, the principal canal of a total length of 4,330 metres; a secondary south canal 1,834 metres in length; and a secondary north canal extending to 6,090 metres long. The total cost of the work was $594,000.

About three years ago, in the inaugural message to Congress of the late President Quintana the problem of irrigation was stated to be fundamental, but was competent only for the nation to undertake, and it was then proposed to prepare and present to Congress a project of law of irrigation.

After considerable discussion in Congress the matter was postponed for a more appropriate time, so that the question of irrigation throughout the whole of the Republic is in suspense. In consequence, the negotiations are also paralysed for having various distinguished European specialists to assume the direction of the work. The idea of the Minister of Public Works was to contract with English engineers who had gained their experience in India and Egypt, as well as Italians, who were specially adepts at this class of work.

### THE SANITATION OF THE CITY.

The authorities are zealously attending to the sanitation of the city, and by the Law No. 4,158, sanctioned in 1906, they hope to complete the supply of potable water in the radius comprised in the last project of Engineer Bateman. In less than three years part of this work will be completed to the eight new districts, containing a population of about 150,000. For the additions to the drainage of the city the Executive Power has contracted for work to the amount of $1,796,111.39 and part of this work has been finished or is being rapidly pushed forward.

### MINES AND METALLURGY.

While Argentine is best known as a pastoral and agricultural country, it is well known that considerable mineral wealth is found over a wide area of its territory. Some of these have been exploited, while others are being studied with the object of forming companies

for their working. As usual, the position of these mineral riches are far away from centres where ways of communication are found and, in fact, altogether devoid of roads for transporting the mineral unless on the backs of animals. Perhaps this has been the greatest drawback for years to any attempt being made in many of the mineral zones to find if such could be exploited with profitable results. Recently either the Provincial or National Government has contemplated the erection of ærial ropeways to some of the mining centres; but very few have been erected and these solely by the companies interested. Until the Government has provided this or some other mode of conveying the material from mining districts and metallurgical centres, the Republic can never hope to take a prominent place in mineral products.

Another drawback is that instead of the National Government granting patents and having the overlooking of all mines, these duties are assigned to the officials of the different provinces, with the consequent lack of uniformity of legal procedure and no end of favouritism.

According to the mining code in force the mines are divided into three classes :—

> (1) Mineral that is found in the soil and is considered an accessory that belongs exclusively to the State and can only be exploited by virtue of a concession granted by a competent authority: (2) Minerals by reason of their importance are considered as preferently belonging to the owner of the land; and (3) minerals that owing to the conditions of the place where they lie are destined for the public good, minerals that belong only to the proprietor, and nobody can exploit without his consent, unless by reason of public utility.

As there are now no regular inspections made by the authorities, either national or provincial, or any official returns kept, no reliable statement of the actual quantity of the mineral products can be obtained. Undoubtedly the territory which is richest in minerals is Neuquen, away towards the frontier of Chile, about 400 km. from Limay and 700 km. from the Pampa Central. Here there is a region of about 35 km. in extent very rich in auriferous soil. Gold in a fine state is found in Neuquen River and its tributary streams. About half a dozen companies have been formed to work the region; but with what success is known only to those in the inner circle of each.

In this district the Neuquen Proprietory Gold Mines Co. recently inaugurated ten modern crushing machines capable of elaborating 30 tons of auriferous quartz per day.

The Neuquen territory also possesses silver, copper and other class of minerals.

In all the provinces belonging to the Andine group, such as Mendoza, Rioja and Catamarca, there is important mineral wealth, including gold, silver, copper, nickel, tin, cobalt, rock crystal, topaz, and many varieties of marble; but so far they have in a great measure been undeveloped. Most of the mines are mixed, yielding copper, gold and silver. In Rioja, the principal mining centres are in the hills of Famatina, situated about 5,000 metres above the level of the sea. At one of these mines the regulus is stated to have produced from 60 to 65 per cent. of copper, with a proportion of gold and silver.

One of the principal copper companies in Catamarca province (where there are about 200 mines) has its mines in the mountains of Capillitas with reverberating furnaces some distance away, the material being conveyed from the mines to the works by an ærial tramway. A London company has an interest in the mines, which are the largest in the Republic.

Coal is found in various provinces, and borate of lime has been worked with good results in the Province of Jujuy.

Away to the southern extremity of the Republic, particularly in Terra del Fuego, several gold dredging companies have been at work for some years, but the great expense of such machinery and the conveyance of it thither, combined with the limited number of working days throughout the year owing to

frequent storms, make the financial success of the working of such auriferous beds somewhat uncertain.

Salt of excellent quality is found in various provinces, that met within the lakes of the Province of Buenos Aires being reported to be superior of that of Cadiz in Spain.

For many years petroleum has been encountered in different parts of the country, notably some time ago at San Rafæl; but it has been only during the past year that these oil springs have been discovered giving forth any considerable quantity. These have been found at Comodoro Rivadava, in the Chubut Territory, and at Oran, in the Province of Salta. This oil is said to be of excellent quality, with a peculiar smell like that of wine. The Chubut spring is very large, while that of Oran can constantly feed a 3 to 4 in. pipe, and the engineer states that as it stands about 400 metres higher than the Bermejo at Embarcion (near where the projected railway to Formosa will pass) it will be easy to run the oil thither.

## *BRAZIL, CHILI, AND URUGUAY.*

*By Sir C. PURCELL TAYLOR, Bart., D.Sc., &c.*

# Brazil.

BRAZIL is by far the largest state in South America, having an area of 3,218,166 sq. miles with a coast line of 3,700 miles, not counting the banks of the enormous rivers. The length from north to south is 2,600 miles, and the width from east to west 2,500 miles. It is nearly twelve times the size of Chili; and is, as nearly as possible for a chance division of the Continent, the exact half of South America.

The population has not yet been exactly ascertained, owing to the difficulties of taking a simultaneous census over such an immense extent of country. It is estimated at 20,000,000, of which only one-half are of European origin. This works out at six persons to the square mile.

Down to the beginning of the nineteenth century Brazil may be said to have had no history at all. The colonial policy of Portugal absolutely forbade the slightest intercourse with other nations, and as Portugal produced nothing in the way of manufactured goods the inhabitants of the colony could not obtain a single article of necessity.

After political changes which seem incredible, the independence of Brazil from the mother-country was proclaimed on the September 7th, 1822, and the Prince Regent (Dom Pedro) was immediately afterwards proclaimed Emperor. He was better as an Emperor than as a statesman, but he was not quite the man to nurse a young country. He abdicated on April 7th, 1831, in favour of his son, who thus became Dom Pedro II., the second and last Emperor of Brazil. Under his wise and enlightened government Brazil attained rapidly the foremost place in South America, and to a very prominent place in the political world. He was, however, deposed on the November 15th, 1889, and the Republic of Brazil proclaimed.

What Dom Pedro II. was deposed

for, or what benefit the country could be supposed to obtain by his deposition, nobody has ever been able to explain. And, notwithstanding all the streets named after that "Fifteenth November," no one will be found now to deny that his deposition was ungrateful and unwise from every point of view, for no country ever had a more disinterested servant or a truer friend.

### HARBOURS.

Brazil is blessed with several excellent harbours.

Starting from the northward we have—

1. *Para*, one of the mouths of the mighty Amazon. This harbour is chiefly used by the steamers calling for india-rubber, the chief supplies of which are found on the banks of the Amazon and its tributaries. Large works are now in progress here for the improvement of the harbour, by the construction of a long quay with a goodly supply of cranes; and when these are finished the port of Para will be equal to any on the Atlantic coast.

2. *Manaos.* The golden city of Manoa, to find which Raleigh spent the best years of his life, and for not finding which he was judicially murdered. It is nearly 1,000 miles up the Amazon from Para, and is accessible to ships of 9,000 tons deadweight capacity. It was not always so accessible, for down to 1866 no foreign ship was allowed to come above Para, but in that year the wise policy of Dom Pedro II. opened Manaos to the ships of all nations. It is now a very fine, clean and handsome city, and very large dock works are in progress there. It is rapidly taking away from Para the chief portion of the rubber trade, and, from its position in a geographical centre, it must become the most important place in the north of Brazil. Companies have recently been formed in London for the improvement of the city of Manaos, and a large quay is to be built there so that ocean-going steamers may load alongside.

3. *São Luiz*, known to seamen as Maranhão. This harbour was at one time the most important in Brazil, but it has been allowed to silt up. It is now more a commercial city than a port, and it has some very fine educational institutions. A railway is to be constructed between São Luiz and Caxias, with a branch from São Luiz to Itaqui.

4. *Pernambuco*, formerly known as Recife. This is a natural harbour formed by a long reef of coral running parallel to the shore. It is accessible to vessels of medium size only, but all the large steamers call at the place, although they have to lie outside the reef, and a very high sea runs there sometimes. Several projects for the improvement of the port have been formulated, and a scheme has at last been decided on, but matters have not got so far that I can give any details of it. It was from Recife that the first Brazilian railway was constructed.

5. *Bahia.* The ancient capital of Brazil, founded in 1549. It is a natural harbour, the city standing at the head of the bay. It is not so much used now as a port, but it is emphatically a city of colleges.

6. *Rio de Janeiro*, described later.

7. *Santo.* A coffee port, and the terminus of the São Paulo Railway.

8. *Porto Alegre.* The chief city of Rio Grande do Sul. There are several shipyards in this city, constructing river and coasting steamers in wood and iron, and there are two large engine works, making marine engines (screw and paddle) and electric light plant. Works are now about to be commenced for the construction of new quays for the accommodation of ocean steamers; but in this case also I am not yet able to furnish particulars.

*Rio de Janeiro.* The greatest engineering work now being carried on in Brazil, or indeed in all South America, is the construction of the new quay at Rio de Janeiro, and certain improvements in the city, to keep pace with this work.

The quay is to have, when completed, a length of 3,500 metres, and the whole is to be finished by June 30th, 1910. That is the date fixed by the contract; but as the machinery designed by the writer for this work has accomplished its task in about three-fifths of the time allowed, the whole quay ought to be finished in the early part of 1909.

The site of the quay was, before operations were commenced, a ragged edge of shore. The quay is constructed at a distance from this shore sufficient to allow of the pontoons floating clear of all obstruction, and the gap between the quay wall and the shore is afterwards filled up and paved on the surface. The new quay wall joins on to the small lengths of existing quay, so as to make a front to the river that is perfectly level and harmonious.

Some trouble was experienced at first owing to the nature of the bottom, which was found to be tufa covered with mud and detritus, and numerous trial

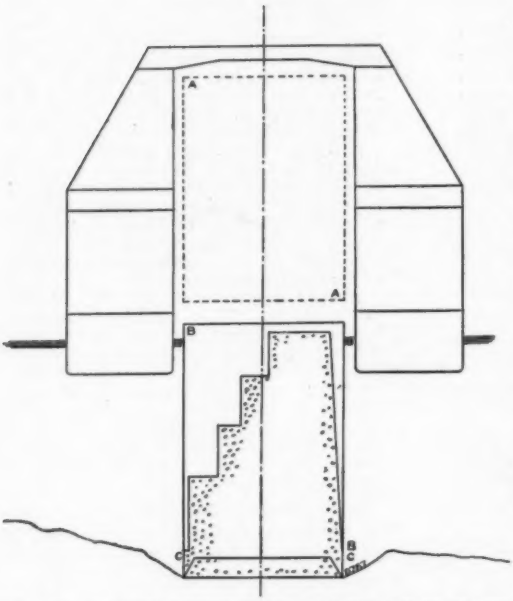



FIG. 1.—RIO DE JANEIRO HARBOUR WORKS. SECTIONAL SKETCH SHOWING METHOD OF BUILDING QUAY WALL.

borings had to be made before the line could be determined.

The method of operation is as follows:—

The bottom is dredged level on the lines of the quay wall, and for a sufficient margin on either side, until a firm foundation is reached. Then the quay wall is built up on this site in large concrete blocks, up to 3,000 or 4,000 tons weight each, by the means next to be described, and which are illustrated in the accompanying section. Two pontoons or boats are constructed, each about 100 ft. long and 20 ft. wide. These are united, and at the same time kept apart, by a heavy framed gantry. This gantry also encloses and supports a huge cofferdam.

The whole structure, which is called the "Neptune," is then moored with its centre line directly above the centre line of the foundation of the wall.

The cofferdam is next raised by means of the winches at the top of the "Neptune," to its utmost height, as shown at *A A*, Fig. 1, which leaves a clear headway under it.

A caisson, *C C*, of the same horizontal dimensions as the cofferdam is then floated underneath.

This caisson is a mere tray, having its edges turned downwards so as to give a height sufficient to allow of men working on the bottom in the caisson, as in a diving-bell. It is provided with air pipes and locks lying on the top of the caisson. This caisson forms the foundation (or rather the skeleton of the foundation) of the quay wall.

The caisson being brought exactly underneath the cofferdam, the latter is lowered down until it rests on the caisson, and the two are then bolted together so as to make an air-proof and water-tight joint. At the same time the air pipes are erected and bolted together, also with air-proof and water-tight joints.

The cofferdam and caisson now form a huge rectangular hull which floats on the water, but is held and guided by the gantry, so that it can only move in a vertical direction.

Shutters are now erected inside the cofferdam to mark the outline of the section of the wall, which is now built up with concrete on the upper surface of the deck of the caisson.

As the building of the concrete wall progresses, the cofferdam and caisson sink under its weight deeper into the water, the air and material pipes passing upwards through the concrete, which completely encloses them.

So the wall sinks lower into the water until at last the lower edges of the caisson rest on the excavated bottom as shown in the full lines in the section. Air locks are then fitted to the tops of the air and material pipes, and air is forced into the lower chamber of the caisson, which thus becomes a huge diving bell, all the water being expelled.

The interior is now lighted by electricity, and the bottom carefully surveyed for faults.

All being well, concrete is now worked into the corners, and the whole of the interior of the caisson is afterwards filled up with concrete until a solid mass of concrete rests on the bottom of the river.

Work is continued on the top of the wall until it rises above low-water mark.

As soon as that point is reached, work is stopped. Water is let into the cofferdam, and the

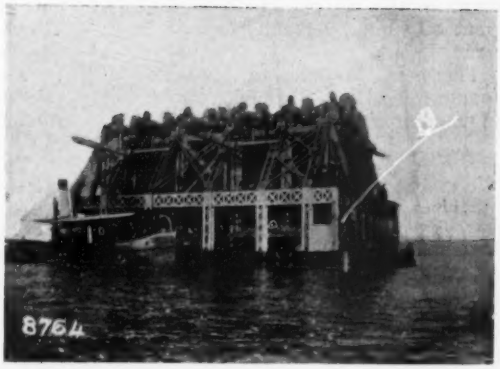



FIG. 2.—RIO DE JANEIRO HARBOUR WORKS. GENERAL VIEW OF MACHINERY FOR BUILDING QUAY WALLS UNDER WATER.

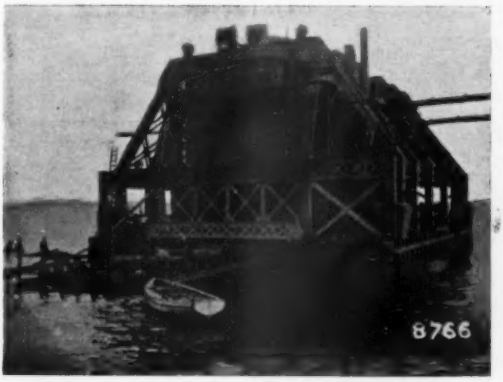



FIG. 3.—RIO DE JANEIRO HARBOUR WORKS. CAISSON BEING FLOATED UNDER COFFERDAM.

bolts holding the cofferdam and caisson together are released. The cofferdam is then raised to its utmost height when it clears the top of the completed wall. The "Neptune" is then towed and warped along in the line of the foundation until the next section is reached, when the whole operation commences again.

The requirements were that 100 ft. of wall should be constructed in 40 days; but, as a fact, 100 ft. have been completed in 24 days. The average is 25½ days.

The space between the sections is filled up with concrete, and the top of the wall finished afterwards.

The stone required for the upper part of the quay is obtained from a quarry near by, which was bought for the purpose.

All the work and machinery of this undertaking was arranged for in London, and, in fact, all

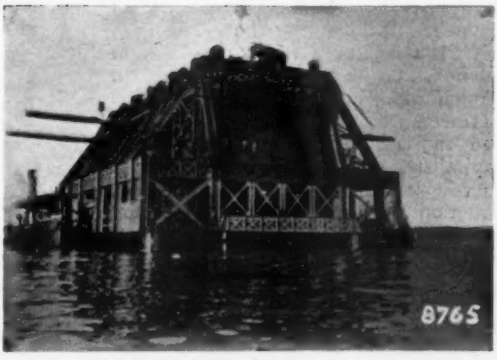



FIG. 4.—RIO DE JANEIRO HARBOUR WORKS. COFFERDAM RAISED TO ALLOW CAISSON TO BE FLOATED UNDERNEATH.

the machinery and plant required for this great city improvement has long been arranged for.

There is, however, a considerable opening in Rio de Janeiro for small engineering and repair shops.

### RAILWAYS.

The first railway in Brazil was a short suburban line of 10 miles in length, built to connect the city of Rio de Janeiro with the suburb of Petropolis, where the Emperor's palace was situated. It was opened on April 30th, 1854. A few years afterwards, the inhabitants of the coast near Pernambuco, and in the neighbourhood of the San Francisco, felt the need for a railway to connect them with the port of Pernambuco. Sketch plans were prepared by some engineers who were then in the country, and the aid was sought of London capitalists, who, after an independent survey, found the money for the construction of the line. This was the railway from Pernambuco to Garanhuus, which now forms part of the system of the Great Western of Brazil Railway Co. This was afterwards extended to Maccio with a branch to Assemblea.

The success of these (although not very great in a pecuniary sense) was sufficient to bring about the construction of another line from Pernambuco to Parahyba, and this was afterwards prolonged to Natal.

The Central Railway runs from Pernambuco westward. It is 100 miles in length and is now being extended for a length of 25 miles.

There are now the following lines in Brazil :—

In the state of

S. Paulo, 4136 kilometres ; Minas, 3,650 ; Rio de Janeiro, 2,335 ; Rio Grande do Sul, 1,610 ; Bahia, 1,511 ; Pernambuco, 813 ; Parana, 645 ; Ceara, 449 ; Alagoas, 353 ; Espirito Santo, 258 ; Parahyba, 141 ; Rio Grand do Norte, 121 ; Sa. Catharina, 116 ; District Federal, 107 ; Maranhão, 78 ; Para, 61.

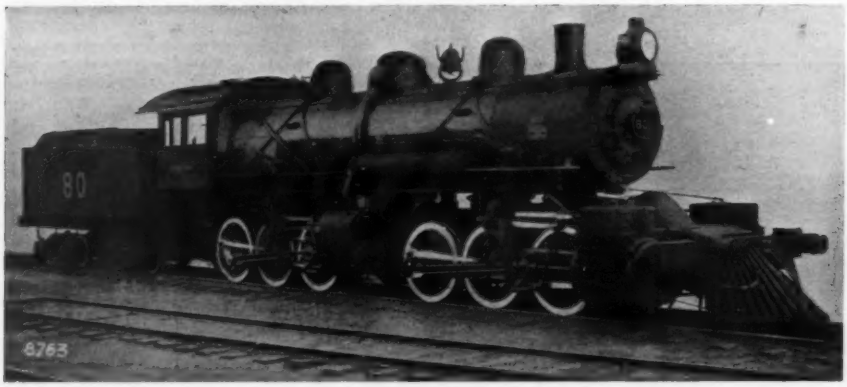



FIG. 5.—TWELVE-WHEEL MALLET COMPOUND LOCOMOTIVE: CENTRAL RAILWAY OF BRAZIL.

It will be seen that the first three states possess more than half the total mileage. The four longest lines are—

The Leopoldina, having a length of 2,258 kilometres ; the Central, 1,566 ; the Mogyana, 1,323 ; the Panlista, 1,023.

The Central Railway has lately acquired three locomotives of the "Mallet" type from the Schenectady Works of the American Locomotive Co. The total weight of each engine (without the tender) is 206,000 lbs. The leading dimensions are :—

Cylinders—dia., high pressure, 17½ in. ; low pressure, 28 in.
stroke, 26 in.

Wheels—dia., 4 ft. 2 in.
Heating surface—fire-box, 121·5 sq. ft.
tubes, 2,195·2 sq. ft.
Grate area, 41 sq. ft.
Working pressure, 200 lbs.
Total weight of engine and tender in working order, 304·300 lbs.
Total wheel base of engine and tender, 55 ft. 2¼ in.

The building of railways in Brazil suffered a severe check in the financial crisis of 1896, when all work was suspended; and during the interregnum the works already completed were suffered to fall into decay. However, that crisis past, every effort was made to repair the damage; but, as always happens in such cases, immense loss was sustained by the stoppage and the neglect to take the most ordinary precautions against decay.

It must be admitted that the monetary returns from the existing Brazilian railways are not what they ought to be in proportion to the immense sums expended in their construction. This is due to two causes. First, all the lines are on the coast where transit by road and boat are more or less practicable. Second, owing to their being on the coast the lines run amongst very mountainous country where great engineering difficulties had to be overcome. The writer is compelled to say that as investments some of these railways do not justify their existence at present. He has, however, reason for knowing that their position and earning powers will improve in the near future.

The policy of the Brazilian Government at the present time is wisely set towards the linking up of the many scattered lines, and thus making a complete system, tending rather to the convenience of the public than to the peculiar advantage of the individual railway companies.

### IRON AND ENGINEERING.

Much more has been done in these two industries in Brazil than in any other South American State. There is plenty of iron ore and other requisites for iron manufacture, but nothing more than experiments have hitherto been made. There are not any bloom mills or rail mills, but there are many foundries using imported pig, and a goodly number of shipsmiths at the ports. Iron shipbuilding for coasting and river steamers is carried on at Porto Alegre, where there is also a good repair shop and an engine shop capable of making marine and electric light engines up to 600 h.p.

At the other ports there are repair shops for marine engines, but there are not any large dry dock and repairing shops as such. What there are belong either to the Government or to the shipping companies, and their use is only to be obtained as a favour, in addition to the money. The Government has frequently been pressed to throw open their dry dock and repairing establishment to the use of the ships generally, but they have not yet seen their way to do so.

### BRASS WORK.

Brazil being a Roman Catholic country, there is naturally a considerable demand for the works of art consonant with that religion, and the country being wealthy there is ample scope for the artist's proclivities. Brass and bronze crucifixes and statuary are made in great quantity, and so are the usual accessories of a Roman Catholic church — candlesticks, altar railings, gates, monstrances and so on.

There are said to be 200 brass-founders in the country making these goods, and the taste and skill of the artists is of a very high order.

This artistic work almost engrosses the whole time of the various foundries. They do not make any attempt to compete with the cheap imported brass furniture and similar goods.

### MINERALS AND METALS.

Beyond precious stones (amongst which the Brazilian diamonds reign supreme) there is not much to be said about minerals in Brazil.

They exist in enormous quantity, but they have not been steadily worked as a settled industry; and, owing to the enormous agricultural wealth of the

country and the consequent prosperity of the inhabitants, the people have not troubled very much about the very uncertain returns to be derived from mines as usually exploited.

Copper and silver are obtained in some quantity, and a little gold.

Within the last six or eight years a considerable quantity of manganese has been exported.

Diamonds are a Government monopoly. The labourers are nearly all convicts, who are set to do the hardest and most arduous tasks, free paid labour only to be engaged when the supply of criminals runs short. The work is all pick and shovel, and no machinery is used except for cleansing. All the work is done under the supervision of armed soldiers.

The sifting and cleansing machinery is of the simplest type. Some has been bought from time to time by the Government, and the remainder has been constructed on the spot from materials always procurable in Rio Janeiro.

### COAL.

The history of the coal industry in Brazil is rather disappointing. Coal was discovered more than a century ago, but very little was done to work it until steam navigation and railways created a demand for it. Notwithstanding all the natural advantages—for in one place the coal forms the bank of a river—the industry has not prospered, and the railway which was formed to carry the coal has had to fall back on imported coal.

### AGRICULTURE.

The great wealth of Brazil is in her agricultural produce, the chief being (in order of value as exported) coffee, sugar, raw cotton, hides, tobacco, caoutchouc, cocoa.

Coffee is cultivated in garden style, there not being much opening for mechanical tillage, as it requires very little attention; but for the cleaning machinery is invariably used. Most of this plant comes from France, although some comes from Liverpool. There are, it is estimated, nearly 1,000,000,000 coffee plants in Brazil; and they are reckoned to be worth $1 each, the land, buildings and machinery not being included in this estimate. To drive the cleaning machinery water-wheels are used in about two-fifths of the plantations, the remainder using steam.

The process of obtaining sugar from the cane is a very simple one indeed. The cane is pushed into a crushing mill formed of a series of rollers, which crush the cane into dry flat fibre, resembling most of all narrow strips of Chinese matting. The rollers must be so adjusted as to squeeze out the very last drop of juice from the cane. The juice flows into a conduit leading to the clarifiers, where it is freed from fibre, &c., and is then led to the boiling pans, where it is evaporated and concentrated down until it is ready to crystallise. In some factories the old open boiling pans are still in use. Sugar ranks next after coffee in the money it brings into the country. The method of cultivation is the same in Brazil as everywhere else.

The annual production is about 320,000 tons, less than one-tenth of this quantity being exported to the United Kingdom.

The machinery is of the ordinary type, coming chiefly from the Liverpool and Scotch makers, although several French and German makes are adopted elsewhere.

On the larger plantations, very complete sets of refineries have been erected, these consisting of "triple effet" boiling pans in the most approved French style, though several of the refineries have been equipped by Liverpool houses.

In these pans the boiling is conducted *in vacuo*, with the advantage of a lower boiling point, and less fuel (though that is hardly an object on a sugar plantation), but the great advantage is that the product is greater and better.

A great amount of the produce in Brazil is exported unrefined, but the practice of refining is growing. The refining process is as simple as the

crushing and boiling. The raw crystals are dissolved and passed through strainers, and then through charcoal filters. The syrup is then boiled down again into a concentrated state, and is then poured into moulds where it solidifies and crystallises into a lump, taking the shape of the conical loaf or of the thick plate which is now preferred.

Within the last few years, large crushing and refining factories have been erected by independent parties, not sugar growers. They have the advantage that the processes being conducted on a large scale, everything can be done more economically; and therefore the sugar grower gets a better return for his produce than if he crushed and refined it himself. Some of these factories charge for their labour and some take a percentage on the yield.

The skimmings and residue are made into a wash and then distilled into rum.

The crushed cane is thrown about on the fields to dry in the sun, and is then burned under the boilers.

#### ENGINEERING PROSPECTS.

Portable engines are largely in demand, but there is a great difficulty in getting the large agricultural engines up some of the mountain roads. Hence their employment is more restricted than it otherwise would be.

There is a much greater demand for small-power steam engines, capable of doing such everyday work as grinding corn and coffee, and in pumping when there is no grinding to be done. I must say that in this respect the English makers do not succeed as well as their cousins of the stars and stripes. The English engineer turns out very good engines from 10 h.p. upwards, but he has not troubled himself about the very small powers that I speak of. These are in England only to be obtained of the model makers, and they are nothing but models, not designed or fitted in any way for actual hard work. I have seen, however, some very ingenious little engines from the United States, in which the cylinder is enclosed within the boiler, with all the working parts carefully protected against damp and dust. The boiler, too, is of large size, and with ample grate area, so that if good fuel be scarce, it is possible to utilise waste wood and rubbish. The whole machine is in one piece, so that it can easily be carried about on the back of a mule. They last well, too, for I saw one, made in 1873, working capitally after nearly thirty years of indifferent usage. I have frequently urged the small engineers and model makers in this country to take up this branch of manufacture, but with not the slightest success. Yet there is nothing better adapted for manufacture by a man in a small way of business, involving but little expenditure, and with a certain sale.

Windmills for pumping are in use everywhere. Their first cost is trifling, their erection can generally be effected by unskilled hands, and their maintenance is really no more than the cost of oil and paint. They are exported very largely from the United States, in parts, so that they may readily be bolted up; the only part needing particular attention being the pump and its connections. A considerable number are also sent out by firms in and near to London; but the total exported from these islands is but a fraction of the quantity sent out by the United States, where a number of makers lay themselves out expressly for this kind of work, and do nothing else but export windmills in parts.

# Chili.

CHILI considers itself the most enterprising of the South American States, and its inhabitants are probably more wealthy and prosperous than those of the other states.

As will be seen by reference to the map, it is a long, narrow, ragged strip of land, on the western slope of the Cordilleras. Its extreme width is 160 miles, while its least breadth is only 40 miles, the average being 100 miles. Its length and its coast line are about 2,700 miles. The area is 260,000 sq. miles. The population is nearly 4,000,000.

### CLIMATE.

There are four climates in Chili, the torrid, the temperate, the rainy, and the wintry; but except in the last named there are practically no seasons, and no particular difference in temperature. Being on the western slope of the Andes, Chili is more moist and cool (in fact the real meaning of the name Chili is cool) than the Argentine country on the other side of the Andes.

In the northern region beyond Copiapo, there is no rain. South of that part, rain falls; and the quantity of rain increases as you go farther to the southward.

The extreme north is sterile, and this I call the torrid zone. This comprises the desert of Atacama and the province of Tacna.

The latter part is sterile and waterless, but it is very rich in minerals, the deposits of nitrate of soda, ranking first of all, in actual value, while there are immense quantities of gold, silver, copper, tin and sulphur. Of these last copper is the most profitable, as has long been recognised in Chili. For example, there are some very curious proverbs about copper mining that appear to date back to a period before the advent of the Spaniard, and which show that its certainty has long been recognised; for instance—

> "You need a gold mine to work a silver mine, and a copper mine to support both,"

and again—

> "If you work a copper mine you *must* get rich; if you work a silver mine you *may* get rich: if you work a gold mine you will certainly be ruined."

The minerals appear to run all along the base of the Andes, right through the southern part of the country; but only a little gold, some silver, and a little more copper have been worked there.

Chili is the youngest of the Spanish conquests in South America, although to be exact, it was only the northern part that was conquered; and no sooner were the natives robbed by the Spaniards, than the English came down and stole all the plunder from the Spaniards.

Francis Drake, in his account of his voyage in the *Pelican*, speaks of landing at a small convent on the coast, and helping to suppress idolatry by relieving the images and the altar of their ornaments; and in that chapel they show you to this day the record: "This day Francisco Draco (to them it meant Francis the Dragon) ransacked our convent, and despoiled all our saints."

### HARBOURS.

With the exception of Coronel and Valdivia, there are no natural harbours in Chili. All the so-called ports are open roadsteads.

The writer was sent round the world on a special tour of investigation to advise the Government on the fiscal policy to be adopted to facilitate the construction of harbours; but the necessary expenditure would be so enormous that the works have not yet been started. Negotiations have been in progress for a long time between the Government

and certain contractors for the construction of harbours and docks; but the subordinate officials have thrown so many obstacles in the way that years have drifted on without the matter being settled. Only recently has a definite arrangement at last been concluded between the Chilian Government and a German syndicate for the construction of a harbour at Valparaiso. The contractors are to be recouped by receiving the revenue of the harbour for a term of years. The terms are not by any means so favourable to the Government as were proposed by a certain English engineer and contractor; but the latter was treated in such an unbusinesslike fashion that he refused to have any more to do with them. Then the Government had to undertake surveys at their own expense, and accept whatever terms other people chose to offer.

The "harbour" of Coronel is as near one can get to the idea in that it is more sheltered than Valparaiso. It is a coal port.

Valdivia is the only real harbour. It is a river which, until twenty years ago, when dredging operations were commenced, was too shallow to be of much use. There are quays on the river bank where steamers of moderate size can discharge. The town of Valdivia is very busy in manufactures. Tanning was the first industry, and this was quickly followed by the brewing of lager beer, Valdivia being a German colony. Then came a candle factory and a number of others connected with animal produce such as wool, glue, soap, and a canned meat factory.

Valdivia is naturally the chief place for importing machinery and the materials for the operations of the factory; but owing to the nationality of the settlers, everything is of German manufacture.

### RAILWAYS.

From its long narrow shape, Chili is peculiarly well suited for a trunk railway system; but the population is hardly sufficient at the present time to support a large undertaking of the kind. At the same time, owing to the narrowness of the country and the extensive coast line, the produce of the land, whether mineral or agricultural, can be readily brought down to the coast and shipped; so that a large railway system could not rely upon a mineral traffic as a mainstay.

Chili nevertheless has a very complete system in the Chilian State Railway. This extends from Caldera in the north to Osorus below Valdivia in the south, and there are branches to the following ports—Port Huasco, Tongoya, Conchali, Valparaiso (which is the centre and starting point), Port Llico, Constitucion and so by a branch running along the coast right down to Lebu.

Nominally a State railway, it nevertheless owes its inception to the influence of the German settlers and capitalists. It was financed, surveyed and built by Germans, while nearly all the stock is held by German houses.

Besides the Chilian State Railway there are no public lines of railway in the ordinary sense; but there are several short lines from the nitrate officinas to the nearest port. These railways, constructed in the first place for merchandise only, also serve to convey the very few passengers who desire to go from port to officina or *vice versâ*, but their number is extremely small, and only one or at the most two trains a day are provided for their transit.

These railways are entirely owned by the various nitrate companies, and they have nothing to do with the State. The capital has been chiefly found by Englishmen, and all the offices are in London.

They are as follows:—

From the port of Arica to Tacna.

From the ports of Pisagua, Junin, Caleta Buena, Iquique, Patillos, Tocopilla to their respectively adjacent nitrate officinas.

Antofogasta (with the branch from Mejillones) serving a group of nitrate officinas about a hundred miles from the coast and then going onwards in a north-easterly direction crossing the Chilian frontier at Ollague, 270 miles from

Antofogasta, and continuing for another 300 miles into Bolivia. Taltal to Cachinal, with various branches, making in all 220 miles. Chanaral to Lujas, Aranco to Concepsion and Curanilhoe.

Then comes the Chilian State Railway with its branches, commencing at Caldera and going right down to Osorno near the Gulf of Ancud.

There are branches to the ports of Caldera, Carizal, Huasco, Coquimbo, Tongoya, Conchali, Valparaiso (but this is the starting point or head place of the line), Pichilemo (not yet completed), Port Llico, Constitucion, Concepcion, Talcahuano, Valdivia.

The great Trans-Andean Railway joins the Chilian State Railway at Las Vagas, a station on the line about halfway between Valparaiso and Santiago.

The Chilian State Railway, which branches off from Las Vagas, goes as far as Los Andes, about thirty miles from the frontier, where it joins the Chilian Trans-Andine Railway. At present the tunnel through the summit is not yet completed, and passengers have to cross the Summit Pass by coach, joining the present terminus of the Argentine section of the Trans-Andine Railway at Las Cuevas, twelve miles east of the frontier.

The time now occupied is two days and a night, as against about twelve day and nights by the steamer passage through the Straits of Magellan. The saving in distance is no less than 2,000 miles.

### COAL.

Coal mining is a rapidly growing industry in Chili, although its development is not taking place as rapidly as might be.

The first coal pit was sunk by Señor Matias Cousiño in 1870, and the others followed very slowly. At the present time there are the following:—Topocalma, Lota and Schwager (at Coronel), Peumo, Curanilhué and Colio, at Aranco), Lebu, Valdivia, Rio Maulin, Chiloe and Brunswick in the Magelhaens.

The progress of coal mining in Chili has been very fitful, chiefly owing to the immense fluctuations in the price of coal. Sometimes coal was taken out at ballast rates in the ships coming for nitrate, and it was then sold at thirty shillings (or even less) per ton. At other times there was a scarcity, and prices have on more than one occasion reached £9 a ton. Once it ran up to £14.

It will, therefore, be intelligible, that coal mining followed the course of this market, and it never until quite lately was undertaken as a serious and steady business. One pit brought in so little that it was deliberately drowned by letting the sea in. The large quantities of coal now brought from New South Wales keep the price approximately even, and the industry is now in a fairly stable condition. The coal averages the same as that from Newcastle and Sunderland, but nothing resembling the "Welsh" steam coal has yet been discovered.

### IRON AND ENGINEERING.

Some attempt was made to establish blast furnaces about a dozen years ago, but without success. The time was not ripe for it.

The engineers' shops in Chili are all repair shops, and they are capable of supplying a new piston to the largest steamers on the coast. That is all that is required of them. Formerly the chief trouble was the breakage of crank shafts; and it is on record that on one occasion either one or two tugs were sent from England to Callao to tow home a steamer that had broken her crank shaft; but the introduction of the built-up type has minimised such mishaps.

As a matter of fact, the first repair shop in Chili was started by an engineer who had been put ashore from his ship, sick; from this small beginning the shop has grown until it is now capable of everything required in the way of ordinary repairs to engines.

### NITRATE OF SODA.

This is, and will be while it lasts, the main industry of Chili, and the greatest source of wealth. Several men who went to Chili with little more than the

clothes they stood in have realised large fortunes in a short time. The nitrate deposits are the result of the drying up of an inland sea. This seems, before it dried completely, to have become encrusted with earth, which in time developed the growth of various plants and became the home of various small animals and birds. As these died their remains entered into combination with the earthy crust, and this in its turn combined with the semi-solid mass of marine salts beneath, setting up various reactions, resulting in the formation of the great bed of nitrate of soda.

FIG. 1.—SECTION OF THE NITRATE DESERT, SHOWING THE INLAND SEA, WHICH FORMERLY COVERED THE PLAIN.

The first exportation of nitrate of soda took place about 1830, with a cargo of 400 tons.

The exports of this material to-day amounts to, roughly, one and a half million tons per annum, and the tax brings to the revenue of Chili about £1,500,000 every year. The proportion of exportation is (roughly) Germany 10, France 6, Belgium 4, United Kingdom 2½, Holland 1, Italy ¾.

It will be readily understood from the above analysis that Germany has a preponderating influence in the nitrate fields owing to her taking nearly as much nitrate as all the others put together, and this explains the firm situation of the great German mercantile and banking houses in Chili.

Nitrate of soda is sold by the quintal = 101½ lb. English ; but the price varies according to the strength, *i.e.*, according to the percentage of nitrogen in the salt.

The use of nitrate of soda is almost confined to agriculture as a manure.

Many attempts have been made to use it instead of saltpetre in the manufacture of gunpowder ; but, owing to the deliquescent nature of nitrate of soda, such endeavours were quite unsuccessful. The attraction for water was so great that the powder became damp on the slightest exposure, and no ordinary precautions sufficed to preserve it. Consequently its use was confined to blasting powder.

The advantages of nitrate of soda as a manure are so great that the sale of it must go on increasing until the present deposits are worked out entirely. There is a combination amongst all the nitrate companies to restrict production and keep up the price ; but it is most probable that this combination will be broken up by the Government shortly.

The nitrate is found in layers beneath two other strata, the upper of recent sand and the lower of the old earthy crust full of vegetable and animal remains. Beneath the nitrate is salt, and beneath that again gravel.

The method of obtaining it is as follows :—A small hole about half a yard in diameter is dug down through the several layers until the gravel is pierced. Then the hole is enlarged in the gravel to make a chamber for the powder. The powder and fuse are put in and the hole tamped. On the explosion two or three yards of nitrate are blown out and the adjacent layers are loosened suffi-

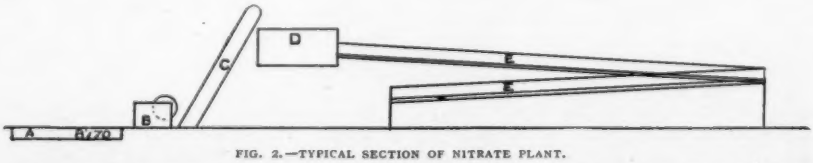



FIG. 2.—TYPICAL SECTION OF NITRATE PLANT.

The caliche is broken up by hand on the slab A, crushed in the rock-breaker B, elevated by the elevator C to the boiler D. In the boiler the nitrate of soda is brought into solution, while the gravel, sand, &c., sink to the bottom of the boiler. The solution of nitrate is then run off into the troughs EE where it dries and crystallises, while the gravel, sand, &c., are removed by doors in the bottom of the boiler.

ciently to allow of more being removed without blasting. A peculiar spoon-shaped shovel with a long handle is used for this digging. The nitrate is then collected and thrown into carts to be taken off to the works, where it is purified for shipment.

It is broken with double-handed sledge-hammers to free it roughly from adhering earth and then thrown into breakers, driven by steam, whence it is thrown into great boilers, where it is simmered for about ten hours, or until all the charge of nitrate is found to be dissolved. As soon as that is accomplished the clear solution is run off into a long series of vats, where it is allowed to crystallise, and the crystals are then drained, dried and packed in bags for export.

It is the dreariest and most miserable business imaginable, carried on in an absolute desert, broken only by the small parties of diggers, the carts, or the railways of the larger works, the works themselves, and with the din of breakers and clouds of steam.

The works are all alike in plan, differing only in size and equipment. The plant required comprises :—Mining tools, picks, gads, spoons, shovels, &c.; powder and fuses; railways with "Decauville" trucks; engines and boilers of the works; sledge-hammers and rock-breakers; "Caliche" boilers; crystallising vats and drying frames; bags for packing.

A great amount of this plant comes from Germany, partly owing to the German influence I have mentioned and partly to the partiality for German goods manifested by the buyers of the London houses.

It is all contracted for in London and Hamburg. The various companies have bought much less freely since entering into the combination. There are no less than eighty-three companies in the "trust."

Quantities of iodine and bromine are extracted from the nitrate liquor; but no particular plant is required, only a quantity of sulphur.

Borax and common salt are also obtained.

The shipping places are Pisagua and Iquique.

Railways run from these two places (there is no semblance of a port about them) to the different nitrate works, but there are only two trains a day that carry passengers.

These shipping places and railways are all in the hands of the trust.

### AGRICULTURAL MACHINERY.

Chili is not an exclusively agricultural country, for, as I have already pointed out, it is only the central region that is good for agriculture. This fertile zone, however, is very well cultivated and is quite prolific. In fact, the farmers are very wealthy men with large estates and very plentiful flocks and herds.

The chief crop used to be wheat, and in the nineteenth century formed, with copper and nitrate of soda, the predominant exports; but within the last twenty years the cultivation of wheat has slightly declined. This is due to the largely augmented population, which demands an ever-increasing supply of vegetables and fruits, articles scarcely cultivated at all before.

Consequently Chili has now begun to import wheat, and it is certain that as time goes on and the population increases, Chili will always be a steady customer for cereals, but her wants in that respect can be easily supplied by California and Oregon.

### FLOUR MILLS.

There are several flour mills of considerable size in the ports; but these, of course, are for the wholesale trade only. In the back country mills may be met with here and there, usually forming the appanage of a farm that is more than ordinarily large.

There is great need for a really efficient flour mill on a small scale. I have constantly had enquiries for flour mills capable of supplying flour sufficient for a large household, for use amongst the farmers and at the country houses where corn is grown. But unfortunately there seems to be nothing on the market at present that exactly meets the requirements.

**FARM MACHINERY GENERALLY.**

This consists of the ordinary run of agricultural machinery; and it is, in my opinion, fully catered for by British, Continental or American houses. I may say, indeed, that the agricultural machinery makers seem to be about the only people who have systematically travelled new countries.

The competition is very keen in this business; and, although there may be a little grumbling occasionally at the delay in despatching an order, the supply of such articles is generally greater than the demand.

But in the matter of repairs there is great room for improvement. These machines all get the worst possible usage. They are neglected for months together, and then they are worked to their utmost capacity by a man who does not know the least about them. When a new part is ordered it very frequently does not fit, or belongs to a different date of machine, or has some other awkward idiosyncrasy; and if it happens to be an important part the machine cannot be used at all. It would save an immense amount of time and annoyance if the makers of these machines would either include a sufficient quantity of spare parts with the original machine, or arrange for a stock to be kept in the principal cities.

This is about the only suggestion that I have to offer to the agricultural machine makers. I know that there is a great deal to be said for and against. that my method would enhance the original price, and might, therefore, prevent a sale being made and so on; but, on the other hand, the fact that one could always get his machine repaired without a moment's delay in sending for the part (even to the nearest port) ought to be sufficient to counterbalance the increased cost.

But, arising out of the repair question, I may point out that there exist many openings in Chili for small repair shops equipped with a forge and a 6-in. screw-cutting foot lathe. There are countless jobs of repairs and renewals, but against this prospect I must in justice emphasise the difficulty of getting the raw material.

# Uruguay.

URUGUAY is, of all the States of South America, the country best gifted with means of communication. Bounded on the east by the Atlantic, on the south by the estuary of the La Plata, and on the west by the Rio Uruguay, it has a coast line of 800 miles, with numerous harbours, while on the north it is bounded by Brazil.

The area of the country has not been exactly ascertained. It is about 80,000 sq. miles on the accepted limitation of the Brazilian frontier, and the total population is 1,000,000.

The climate is very pleasant and equable, something like that of the middle zone of Chili; but more variable and perhaps more acceptable to an Englishman.

In summer, the greatest temperature known is 88° F., while in winter, in the most severe weather, only puddles in the roads have been frozen. There is a good deal of cold rain in the winter, because the range of the Andes compels all the moisture-laden clouds from the Atlantic to deposit their contents on Uruguay and the Argentine.

The country is exceedingly well watered. The Rio Uruguay is navigable for ocean steamers as far as

Paysandu (350 miles from Monte Video), and to Salto (about 80 miles farther up than Paysandu), for small coasting steamers.

The Rio Negro traverses the country from north-east to south-west, and it falls into the Uruguay. It is navigable by coasting steamer as far as Mercedes (about 70 miles up the Negro from its junction with the Uruguay), and it can be navigated by canoes for its whole length.

There is a very good service of small steamers from Monte Video across to Buenos Ayres in the Argentine, and up the Uruguay into Brazilian territory. These boats are owned in Monte Video, and they are excellently managed, carrying cargo down to Monte Video for the ocean steamers, and affording also very pleasant holiday trips.

The entrance to the La Plata is, however, rather dangerous, owing to the heavy weather frequently prevailing there.

Many disasters have taken place in the estuary of the La Plata, and a local salvage company has been doing a very considerable business for some years in salving wrecked ships.

Until recently large ships had to lie in the roadstead at Monte Video and discharge into lighters, but with the completion of the new docks, ocean-going steamers can lie alongside the quays, thus obviating a great danger to passengers in bad weather, and a great delay at all times. A description of the new dock works is given under the head of harbours.

There are said to be 1,800 small rivers in the whole country, but notwithstanding all this wealth of transit facilities, the country is almost virgin soil.

The only parts that are really in a state of cultivation are the provinces of Canelones and Colonia. These districts raise sufficient grain and vegetables for the supply of the towns, and there is a trifling export of wheat. It will, however, scarcely be believed that the whole of this country should barely raise enough for itself with a population of one to the sq. mile.

Agricultural machinery is not much in demand, and the opportunities for its use are scarcely to be found outside of the two agricultural provinces I have named, viz., Canelones and Colonia. I may, however, add San José.

The chief industry is cattle raising, next (but a long way after) sheep, and then horses.

Close on 700,000 cattle are slaughtered annually, and of these more than one quarter are made into Liebig's extract. Liebig's Co. have a very large establishment at Frey Bentos on the Rio Uruguay, and they either own or charter ships expressly for transporting their own product. Most of it goes to Europe.

Several other smaller firms are engaged in the meat extract business; but as the nature of the business does not afford any scope for engineering enterprise, I need not dwell on it. The only parts requiring actual engineering are the transportation of the carcases and the vacuum plant for the preparation of the extract. These companies, however, have their own engineers, and their plant is made to their own designs and requirements.

In the chilled meat trade there is a much larger opening for engineers.

From Uruguayan ports about 500,000 chilled carcases of beef are exported every year, and there is consequently considerable scope for the erection of refrigerators.

The other exports of the country are nearly all comprised of the products of the slaughtering business—hides, horns, hoofs, glue and hair.

### HARBOURS.

Reference was made earlier in this article to the somewhat dangerous state of the roadstead of Monte Video in certain conditions of the weather.

The bay of Monte Video is itself a very good harbour so far as shelter goes, but the depth is so shallow—only 12 ft. within the headlands—that no sea-going ships can enter. Consequently these large vessels had to lie outside and tranship their passengers and cargo

into lighters—a very dangerous business indeed in the weather that often prevails at the Rio de la Plata.

The Government recognised that this state of affairs was a very serious obstacle to the financial well-being of the country, and they, therefore, appointed a commission to consider the matter and decide on the scheme of improvement most advantageous to the city and the shipping.

Monte Video is not only the sole port of Uruguay for large ships, it is also the port of Paraguay and of the southern portions and the back country of Brazil. The improvement was, therefore, a matter requiring very serious consideration.

In the scheme selected France was successful, and the contract for the execution of the works was entrusted to a Parisian syndicate.

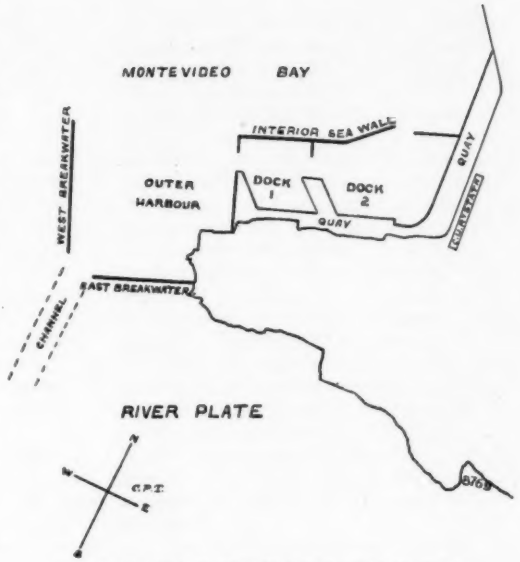



FIG. 1.—PLAN OF NEW HARBOUR WORKS AT MONTE VIDEO.

The improvements in the port at Monte Video consist of—

1. Dredging a channel from the sea round the toe of the city as far as the west front of the harbour, where the terminus of the Central Uruguay Railway is situated. This channel is to be 25 ft. deep below low-water mark.

2. The construction of two moles from the northern face of the city so as to form two partial enclosures, which will be known as the Inner Dock and the Outer Dock respectively.

3. The construction of quay walls on the existing water frontage of the harbour and the reclamation of the foreshore.

4. The construction of two breakwaters to form an outer harbour, and of two smaller breakwaters to form the outer walls of the docks.

The method of construction combines several different systems, which are not usually seen united in one undertaking.

The foundations of the moles are made by building, within a floating caisson, a pillar of masonry and concrete. This pillar is lowered until it rests on a bottom which has been previously levelled by divers. There will be in all 176 of these pillars. The spaces between the pillars are then faced with ferro-concrete piles, and laid over with ferro-concrete lintels. The superstructure of the quay wall is of dressed granite. The breakwaters are formed of blocks of masonry and of concrete dumped into the water by hulks made for the purpose.

The dredging of the entrance channel and the harbour spaces has been a fairly large undertaking.

Eleven bucket and sand pump dredgers and hoppers have been employed for the last four and a half years in dredging the channel, while other and smaller dredgers of the ladder and crab types have been employed on the harbour sections.

The method used was to dredge the whole to one uniform depth, and gradually deepen the whole uniformly, so as to enable the channel to be used at the earliest opportunity.

The docks, however, will not be docks of the European enclosed type with locks and watertight gates, but will have open entrances.

The depth of the whole works—the entrance channel, the outer harbour, and the two docks will be the same—25 ft. below low-water mark.

This depth will permit of the largest steamers now using the port coming alongside the dock quays at all times. The entrance channel is to be marked by luminous buoys.

It is intended to gradually increase this depth by another 2 metres, which will give a depth of 32 ft. below low-water mark.

In addition to the accommodation for the ocean-going steamers, a much needed improvement has been effected by building a jetty of hardwood for the use of the steamers plying to Buenos Ayres and up the rivers, so that these steamers can at all times come alongside, and passengers can walk on board. At the same time the handling of cargo is much facilitated, so that the cargo can be got out in less than a quarter the time previously occupied. Those of my readers who recollect the old state of affairs at Monte Video will be most agreeably surprised by the new arrangements.

The new jetty has a quay space of 500 metres in length, so that it affords ample space for all the light steamboat traffic.

The contract price for the works is £2,400,000.

The works were commenced on July 18th, 1901, and they are to be totally completed before July, 1909. All the substructure has been finished, and the work that remains to be done is simply to finish the superstructure with its bollards, rails, cranes, &c.

There is now available about 300 metres run of quay space.

I do not think there is anything in the equipment of these docks that has not already been ordered or contracted for.

There are not any other harbours in Uruguay, but the whole river Uruguay is itself one long harbour. There are jetties at the places on that river where ships go, and there are many jetties and floating piers for the use of the light river steamboats.

**RAILWAYS.**

Uruguay is very well supplied with railways.

The chief of these is the Ferro-carril Central del Uruguay. This starts from Monte Video and has four great branches, while a fifth is under construction. One line (the Ferro-carril del Oeste) extends north-west, going to the ports of Sauce, Colonia and Mercedes.

Another goes due north into Brazil, crossing the frontier at Rivera.

A third goes north-north-east, and is being extended now in one direction to Centurion on the Brazilian frontier, where it connects with the Brazilian lines; while another branch will run from Nico Reraz to Treinta, on the Rio Olinar.

The fourth is the Ferro-carril Nordeste del Uruguay. This, a short line only, runs as far as Minas. Its length is 122 kilometres. It is also known as the Ferro-carril a Minas.

A very curious incident happened in the construction of this railway. When the line was first laid out it was intended to pass through a certain city, but those responsible for the line were astonished to find that the municipality was strongly opposed to the railway entering their city. Some conferences took place between the projectors of the line and the leading officials of the town to see what the latter wanted, for no person at all versed in the ways of municipalities could doubt what was the real object of the opposition. The grounds of objection were duly discussed and appraised, and the railway company undertook that on a certain day near at hand the required contribution to the improvement fund should be handed over.

The money was duly despatched from the headquarters of the company, and it arrived in the city in question on the evening before the day on which it was to be handed over. As the neighbourhood was rather unsettled the officials in charge of the money—for of course it was all in specie—decided to keep watch with firearms at hand.

Sure enough in the early morning the house was attacked by a number of men, who forced their way through doorway and window, but meeting with an unexpectedly warm reception, they fled, leaving one of their number dead in the room. When day broke, what was the surprise of all concerned to find that the dead man was none other than the Alcalde (or Mayor) of the city, who had conducted all the negotiations!

All the above railways, although formed by independent companies and at various times, are now under the control of the Central Uruguay Railway Co. (of London).

This is the largest railway corporation in Uruguay and operating a total mileage of 950 miles. It has a very well equipped range of workshops at Reñarol, a little way out from Monte Video, and this has recently been about doubled in extent, to afford additional facilities for repair work and the erection of locomotives and rolling stock sent out from England.

On the Central Uruguay Railway there are some notable bridges, viz.:—

| | | |
|---|---|---|
| Santa Lucia | 17 spans of | 15·24 metres. |
| | 3 „ | 25·91 „ |
| | 5 „ | 52 „ |
| | Total length 601 metres. | |
| Rio Negro | 9 spans of | 39 metres. |
| | 22 „ | 18·36 „ |
| | Total length 755·73 metres. | |
| Yi | 41 spans of | 15·25 metres. |
| | Total length 623·25 metres. | |
| San Ramon | 3 spans of | 24·38 metres. |
| | 25 „ | 15·24 „ |
| | Total length 423·66 metres. | |
| Pintado | 5 spans of | 120 ft. 10 in. |
| | Total length 184·14 metres. | |

Next comes the Ferro-carril del Midland, which starts from a junction with the Central Railway at Oparada on the Rio Negro, running north along the valley of Salsipuedes and then, turning to the westward, it runs to Paysandu on the Rio Uruguay. It then follows the course of that river upwards to Salto. At Salto commences the Ferro-carril Norveste del Quareim (where it crosses the Brazilian frontier) and connects with the Southern Railway of Brazil in the Brazilian province of Rio Grande du Sul. There is a branch of this railway from Salto to San Eugenie, a town on the Rio Quareim (or Cuareim) about 100 miles above the junction of that river with the Rio Uruguay just above Santa Rosa.

The third great system is the Ferro-carril de Maldonada and Punta del este. It follows the Atlantic seaboard to Maldonado, Rocha, San Vicente, and is intended to join with the Brazilian railways in the province of Rio Grande du Sol. Although called Punta del este, it does not go nearer to that point than Maldonado.

It may be wondered why these railways should be pushed on and extended so rapidly, seeing that the population is so extremely scanty; but the matter will be easily understood when I explain that the back country of Brazil finds its most convenient outlets in the ports of Paraguay.

### MINING.

There is scarcely any mining in Uruguay. A little surface working and washing for gold is done in a very small way at various places on the rivers.

Coal is known to exist, but it is not worked in a large or steady way.

There are many very rich deposits in Uruguay, but I am not at liberty to give any information about them.

### ENGINEERING GENERALLY.

All the engineering industries of Uruguay centre at Monte Video.

There are two establishments owning dry docks and repairing slips, while several other firms—the tug owners, the river steamer owners, and the coal importers, have small slips and repair shops for dealing with their own requirements.

The Monte Video Gas Co. is a native concern, although served by an English staff; and the same remarks apply to the water company. These two companies own very small repair shops.

Beyond these, there are none but the most ordinary establishments.

The electric tramways of Monte Video are owned and operated by native companies.

### ENGINEERING PROSPECTS.

It will thus be seen that the country does not offer much advantage at the present time to the manufacturing engineer.

None of the industries involve the use of much machinery. What little machinery that is required in the slaughtering and preserving trade is obtained in London, and repaired, so far as may be, by the factory's work-people on the spot.

Agricultural and domestic machinery are imported by the two or three merchant houses and storekeepers at Monte Video; and these firms handle the small number of bicycles, carriages and motor cars imported.

# Ecuador.

*By A. MANN.*

THE Republic of Ecuador, situated on the Pacific Ocean, within the parallels of 2 deg. north and 4 deg. south, has an estimated area of 120,000 sq. miles, over one half of which is practically unexplored and inhabited solely by savage tribes. This last portion is located between the river Amazon and the eastern range of the Andes, and its denizens exercise sovereignty over the entire region, undisturbed except by the raids of rubber hunters.

The remainder of the Republic has a coast-line on the Pacific of about 400 miles, bordered north and south by the Republics of Colombia and Peru respectively. It has a variety of climate, ranging from the warmth of the coast, tempered by cool south-westerly breezes from the ocean, to the damp pestiferous temperatures of the tropical forests, and the frigid cold of the high Andean plateau.

The portion of interest, from an engineering point of view, is the coast and inter-Andean provinces, the former specially, as the entire practical resources of the country are contained therein. To this portion, therefore, reference will be made exclusively in this report.

### MINING.

So far as is known up to the present, Nature has not endowed the country with a bounteous measure of mineral wealth, for with the exception of an American company—the successor of the British "Grand Zaruma" Gold Mining Co.—no serious mining of any description is being carried on. This auriferous zone is in the south-west of the Republic, but though various lodes of gold bearing quartz, from a few inches to twenty feet in width, have been developed, the refractory nature of the ore, combined with the great expense of transport of heavy machinery to the seat of operations, has deterred further enterprise in this industry. It is, however, satisfactory to know that, after many years' work and the expenditure of a large amount of capital, the American company has placed its property on a paying basis.

Some distance to the east of the Zaruma district, ores containing considerable quantities of silver have been known to exist for a generation, but the low price of this metal and the vile nature of the highways, which are mere mule tracks, have dissuaded prudent investors from taking an interest therein.

The sole remaining mineral region

worthy of mention is auriferous, and is situated nearly on the border of Colombia, at a distance of from 20 to 50 miles inland, on the banks of the river Santiago and its affluents. Notwithstanding the abundance of legendary lore regarding its mineral wealth, the bitter experience of the "Playa de Oro" mining company and other foreign mining associations has gone far to prove that, though gold is found in the district, it is disseminated only in microscopic quantities, and although over £250,000 has been expended, the undertakings have been abandoned. It was alleged by persons who were presumed to know, that capital, machinery and energy were alone required to transform this district into a modern California, but the provision of all those in abundance proved the fallacy of dependence on the reports of sanguine, superficial or interested mining experts regarding a region in which exploration has to be effected amidst dense tropical jungles, in a damp atmosphere, under a torrid sun, and subject to the attack of myriads of insect pests.

#### PETROLEUM.

There is a probability that crude petroleum may be discovered along the entire coast-line, as the geological features of this zone are similar to those of the petroleum districts of Peru, in which important deposits of this valuable product have been worked profitably for over twenty years. Some months ago, at a small town a few miles south of the equatorial line, whilst a well was being driven in search of water, crude oil flowed for a few days. Between this town and the Peruvian oil fields, in a district adjacent to the outer extremity of the Gulf of Guayaquil, a primitive manufacture of pitch has been carried on for centuries, from a petroleum which filters into superficial wells of from 6 to 10 ft. in depth in small quantities.

#### SULPHUR AND LIGNITE.

Sulphur is found in the neighbourhood of extinct volcanoes in various parts of the mainland and in the island of Albemarle in the Galapagos group (the latter not yet extinct). It is commercially pure occasionally, ranging in colour from a dark orange to a light canary yellow, but being so far removed from business centres, and situated in very inaccessible locations, is not a factor of importance. It is used in the country for bleaching sugar, straw hats, &c., and as a fumigating disinfectant, due to the outbreak of plague in Guayaquil, it has acquired a value previously unknown: being protected by import duties, it is sold at prices of from 20*s.* in normal times, to 30*s.* to-day, per 100 lbs.

Another mineral indication, of an unimportant order, is the presence of a few outcrops of impure lignite, discovered betwixt the two ranges of the Andes. Great expectations were formed as to their value, and definite work was performed in opening them up by means of tunnels and drifts, specimens being extracted from various depths; but though visited and reported on by European and American engineers, work has been abandoned for some years, although the railway, which passes through the district, imports its fuel from abroad. The substance extracted from the seams was of a coaly appearance, but so much impregnated by sulphur and earthy matter as to crumble into dust after a few days' exposure to the influence of the weather. The district in which this mineral has been found is at an elevation of about 10,000 ft. above sea level.

Although Ecuador may not have been gifted by Nature by important mineral wealth, it has been amply compensated by the grant of climatological conditions which produce a vegetable wealth in rare profusion. Where the soil is suited to its growth or cultivation, it yields cocoa, coffee, rubber, cotton, rice, sugar cane the ivory nut or coroza (cut up to manufacture buttons and similar articles), the toquilla palm (from the covering of the pod the straw used for weaving the so-called "Panama hats" is produced), many barks and resins, employed in medicine and other arts, and a multitude of delicious fruits. The climate of the

coast provinces is warm, the temperature ranging from a maximum of 94½° to a minimum of 66° F., with light south-westerly breezes during the greater part of the year, not a very heavy rainfall from December to May, with the remaining months dry: hurricanes are unknown, and though subject to periodical earthquakes, no catastrophe due to such has occurred on the coast within historic times.

The inter-Andean plateau runs north and south at an elevation of from 6,000 to 10,000 ft. Its soil is generally of a poor quality and of volcanic origin: it, however, produces very fine potatoes and several cereals, chief of which are barley and wheat; the latter, whether due to the elevation at which it grows or to the chemical constituents of the soil, does not produce a good flour, for though several excellent flour mills have been erected in the interior, a good baking flour has not been turned out up to the present.

The most important interior products outside of the cereals and vegetables are cotton, wool, straw hats and hides, the two former employed entirely by native manufacturers. In order that an impartial judgment may be formed of the relative importance of the two regions treated of here, it may be mentioned that the annual value of exports of the Republic is about one and a half million pounds sterling, the share pertaining to the interior not exceeding £50,000.

### ENGINEERING POSSIBILITIES.

The field for engineering development is comparatively circumscribed, not wholly from lack of initiative or want of capital, but to the fact that only the most simple implements are required in the cultivation or collection of the more valuable vegetable produce, for, so far as export is concerned, only cotton and coffee need the aid of machinery to put them in marketable form, and the quantity of either exported is insignificant.

Nevertheless, under Government auspices, or guarantee, a narrow gauge railway has been in course of construction, with periodical interruptions, since the year 1873: during the past ten years considerable progress has been made, and, in partially completed form, it has reached within twenty miles of the capital, Quito.

Outside of native lumber, the material employed in the construction of the railway is almost exclusively American. The means of rapid transit across the Cordillera is of great political and mercantile importance to the Government and general community, as it gives access to cumbrous and heavy material previously carried by relays of Indian labourers at an enormous cost, and it may open up a fresh field for the importation of various classes of agricultural machinery. Owing to the heavy gradients and abrupt curves employed, haulage is a huge item on its scant revenue: consequently rates are abnormally high, and a successful competition to the locomotive is carried on by thousands of mules and donkeys; with lower rates this feature may disappear.

A few miles of track have been in operation on the coast, leading to the cocoa orchards of Machala, built by means of a tax on this valuable bean.

### THE SUGAR INDUSTRY.

The most important industry on the coast is the manufacture of sugar, and it is pleasing to know that the bulk of the machinery employed and that which has given the greatest satisfaction in efficiency and durability is British. As, however, the gross output hardly exceeds 7,000 tons, the scope for extension is limited. No striking development in this line may be anticipated, as it has been found impossible to produce sugar here at less than 8s. to 10s. per 100 lbs.: being free from much outside competition by the cost of freights, port dues, &c., the growers can sell at from 12s. to 14s., and yet withal do not prosper.

A considerable mileage of portable railway track is employed in the cane fields, as also small locomotives and cars: ploughing was tried for a season or two by the more advanced estate owners, but was found too expensive; now the only

attention the cane gets is weeding and replanting blanks.

### MOTOR BOATS.

After this in importance comes the water carriage, as the commercial emporium, Guayaquil, is situated on the right bank of a wide and deep river, which has many navigable branches leading through the cocoa zone. There are about twenty steamboats, of light draught, from 40 ft. to 110 ft. long and about thirty motor boats of from 20 ft. to 45 ft. long plying in the passenger, freight and milk traffic of the city: but as this industry has outgrown the regular demand and rate-cutting competition is keen, future orders will be of a modest nature, though motor boats and motors will be wanted by the wealthier farmers from time to time, the sizes of motors likely to be ordered being from 5 to 10 h.p.

### RICE AND COFFEE MACHINERY.

Next comes rice and coffee husking, for which a number of small installations have been put down of late years. Twenty years ago these were all of British manufacture, but to-day the small compact and inexpensive type of American huller is running the older machines very hard. Being easy to repair, requiring less motive power and moderate attention, they are much favoured by the mill owner here, who has seldom a demand for over five tons per day, and this only during the season.

### WOODWORKING MACHINERY.

What would, at first sight, impress a foreigner is the immense forests to be seen along the river banks, and if meditatively inclined, he would presume that a vast field for lumbering was going to waste through neglect. Such is one of the many errors to which visitors are prone,—for not over 5 per cent. of the huge trees to be seen around (except the mangrove, which grows where its roots are bathed by brackish or salt water) are of any commercial value, the remainder being of a soft pithy wood, susceptible to rapid natural decay and to the inroads of the white ant. Nevertheless this alone does not account for the lack of industrial activity to be noted in this branch, for another and almost insuperable difficulty is to be found in the need to cut and keep open roadways to the river banks, for haulage purposes, through the closely laced jungle. If left for from two to three months these tracks cannot be recognised from the virgin forest, owing to the exuberant growth of the suckers from the tree trunks, which shoot out in a few days.

There are, however, two American circular saw mills in the north province, four frame saws of British manufacture and an American band saw in Guayaquil, the last not a success up to the present, as well as a few small circular saws in the interior. The frame saw gives the greatest satisfaction where timber is expensive, the kerf being less than that of the circular saw and on account of the freedom from ridging of the board surface: the maximum output is 10,000 sq. ft. daily per saw.

Previous to the imposition of heavy import duties many shiploads of American pine were sold here, it having been found more profitable to use dressed lumber than to saw up and plane the native article. Ecuadorian woods, with the exception of the soft inferior and the hard *lignum vitæ* varieties, the last unsawable, have a very uneven grain or fibre and are non-resinous, though when polished are very elegant: no machine yet imported for the purpose of planing or tongueing and grooving has given satisfaction, although many have been tried.

There is a well-mounted brewery and ice factory, a soap and candle factory in Guayaquil; but the extraordinary feature of all those establishments is that the only native product employed in the elaboration of their output is water, the malt, hops, oil, tallow, soda, resin, stearine and wicks being imported. One small cotton gin supplies the demand for export, for it has been found that, though the soil is eminently suited for

the cultivation of cotton, the cost of collection is too great to permit its cultivation on a paying basis.

There are a number of rudimentary tanneries, which produce fair leather, several small distilleries for the manufacture of a spirit resembling white rum, the staple stimulant here, and alcohol for domestic uses.

Besides a number of jobbing blacksmiths' shops, there is a good foundry and machine shop, several macaroni, chocolate, coffee-roasting and biscuit factories, all run by steam – the biggest proportion of the engines and boilers being British—and electric lighting plants in Guayaquil and in Quito, the first run by steam, the last by water power. A mule tramway extends throughout Guayaquil with about twenty miles of line, and an electric opposition line is in course of construction.

Guayaquil, being built of wood and cane, is subject to destructive fires. Of late a well-arranged pumping station, with lines of large wrought iron pipe beneath the streets, has been erected, and has already done good work. The installation is American, and cost £140,000.

This city has the only service of water supply by pipe in the Republic, brought from a distance of fifty miles, but as the quantity of this precious fluid which arrives in the city is less than 500,000 gallons daily, a duplicate line must soon be put down, the population of the city being over 60,000.

A well is being drilled at present and has reached a depth of over 900 ft., in search of water, but the typography of the district and its geological features do not point to the probability of this liquid being found. Slight traces of petroleum appear from time to time in this boring, and it may be inferred that on reaching the depth of 1,500 to 1,800 (the depth of the Peruvian oil belt) considerable deposits may be encountered. Should this occur, it will be of great importance to the district, and may tend to an increase in the machinery installations, for fuel is a serious item of expense, coal costing from 45*s*. to 50*s*. per ton, and a cord of wood of 6 ft. by 6 ft. by 2½ ft. Spanish 6*s*. to 7*s*.

### FUTURE PROGRESS.

A few branch lines of light railway to open up the cocoa estates, water supply and lighting of the more important towns, and mayhap a sewerage scheme or two, will fill the practical requirements of the country for many years. Any engineering development outside those will be of a very modest nature, for the financial capabilities of the Republic are not of a brilliant order.

The few native and domiciled capitalists who exist are more inclined to utilise their surplus funds for investment in real estate, or in commercial speculations, rather than engage in industrial pursuits, which generally prove abortive, and in which the labour and administrative problem is a source of constant anxiety and embarrassment. It should be difficult to induce foreign capital to embark in industrial enterprises, from which native capitalists prudently refrain.

A retrospect of the past quarter of a century exhibits a very moderate augmentation of engineering enterprise, and it would be wise to assume that future progress will tend to run on similar lines: much cannot be expected, for though the estimated population of the Republic is one and a quarter millions, not over one-third of this number is engaged in agricultural, commercial or industrial occupations, the assumed remainder being a negligible factor, consisting principally of uncivilised Indians.

In conclusion, I must refer to a matter which demands more than cursory attention, being of much importance to manufacturers, viz., our postal arrangements. By some abnormal reasoning, our postal authorities despatch all British parcel mail "*viâ* the *Straits of Magellan*," a route of over 10,600 miles; the average mail thereby arrives in eighty-five days, whilst if despatched by the Isthmus of Panama, a distance of 5,600 miles, it would be delivered here within twenty-five days.

This gives French and American commercial competitors an enormous advantage over our manufacturers, for hundreds of large packages of lace, wearing apparel, gloves, shoes, hats, scientific implements, &c., &c., are ordered from other countries, on account of rapid transit, of which a large proportion would be purchased in the United Kingdom, were this matter arranged.

On being interviewed recently the chief postal authority explained that he could not understand why the British Post Office should select such a route. He mentioned that the Ecuadorian Government granted a considerable subsidy to the Pacific Steam Navigation Co. and to the Chilian line, besides exempting both from stamp duties, light, pilotage and harbour dues, the latter a most valuable concession of itself for the carriage of mail matter; and that all parcels from France and America arrived by the Isthmus. He recommended, mayhap sarcastically, that one might have parcels sent to France, thereby assuring rapid transit.

It was amusingly humiliating when one of the officials naively remarked, "Perhaps the British postal authorities are not acquainted with the configuration of the South American continent?"

It is understood that the Pacific Steam Navigation Co. is paid by our postal authorities for the carriage of the parcel mail to Ecuador by this long route, so that as it receives nothing from abroad for the short carriage from Panama to Guayaquil, a distance of 800 miles, it is interested in upholding this anomaly. Where it is desired to carry the mails in British bottoms, the Royal Mail Steamship Co., plying to Colon, would comply with this requirement, and, if paid by mileage, at half the rate nearly, whilst this alteration in route would place our parcel mail on the same basis as that of other countries.

This matter must be brought before the Post Office at an early date, for heretofore we have led the world in the efficiency of our postal service, and ought not now to be commercially handicapped by other nations.

# Venezuela.

*By Sr. A. CHERRY.*

It is only lately that Venezuela has shown any activity in manufactures. Twenty years ago mining was practically the only industry requiring machinery. Since then, however, railways have been made in connection with the two principal ports and the towns they serve, and direct communication has been established between Caracas and Valencia by the German railway.

On landing at La Guaira, the principal port, the first thing one sees are the harbour works, built, owned, and managed by a British company. These consist of a concrete pier, with three landing stages, providing a sufficient depth of water for any of the ships which come into the harbour; some fine quays for the smaller coast shipping; a small basin, and a number of spacious corrugated iron buildings for stores. The company maintains its own repair shops, and has a good supply of rolling stock, all of English manufacture.

La Guaira contains a few soap factories and a flour mill for grinding imported wheat, and is also connected

by a small railway running between it and the watering-place called Inacuto, some three miles distant.

From La Guaira to Caracas one goes by the railway, built, owned, and managed by an English company. It is 36½ kilometres long (nearly 23 miles), of 3 ft. gauge, and its curves, which are frequent, range down to 43 metres radius. The greater part of its length is on a rising 4 per cent. gradient, the line running through eight tunnels. All of the rolling stock is obtained from England, and the company maintain a very good repair shop in Caracas.

FIG. 1.—LA GUAIRA HARBOUR, VENEZUELA.

On arrival at Caracas one notices the new electric tramways, which have just started running. This installation is owned by an English company, the work being carried out by Messrs. J. G. White & Co., of London. There are altogether 9 miles of track of 3 ft. 6 in. gauge, laid with 90 lb. rails, and thirty cars, accommodating thirty-two passengers each, comprise the rolling stock. Overhead construction is adopted, the line being suspended from side brackets on posts, which also support the aluminium feeders.

There are three power stations in Caracas and neighbourhood, two belonging to the Gas and Electric Light Company, situated at a distance of 16 kilometres from the capital, and the other in Caracas itself. The Gas and Electric Light Company's stations have a total output of 1,836 kw. The voltage is 5,200 volts at 50 cycles, three-phase. These two stations supply the tramway company during the day up till 5.30 p.m. After that hour the tramways are supplied from their own station by three

Diesel engines of 240 b.h.p. each, running at 180 r.p.m. These engines are belted to three motor generators, which, on the induction side, are wound for 5,000 volts, three-phase, 50 cycles; on the direct-current side the output is 150 kw. at 550 volts, running at 500 r.p.m. There is also a battery connected with this plant, with an ampere hour capacity of 520 amperes for one hour, and 252 amperes for three hours, the maximum charging current being 252 amperes. This battery is by the Tudor Storage Battery Export Syndicate, Limited.

FIG. 2.—VIEW OF ELECTRIC DRIVE IN THE BREWERY, CARACAS.

Caracas contains a brewery, owned by a native company, with £100,000 capital, which turns out about 200,000 gallons of beer annually, and employs regularly one hundred persons.

Mention may also be made of a rope factory fitted up with English machinery for making rope from sisal, which is grown in the country. This has only just started, but is now selling rope in all sizes, from $\frac{3}{8}$ in. to $1\frac{1}{4}$ in. diameter.

A glass factory is in operation, engaged principally in the manufacture of bottles for the brewery, and is a native company, but the whole of the equipment has been brought from Germany, including the workmen. Some difficulties were encountered at the start, but these appear now to be overcome, and the factory is turning out about 10,000 bottles per day, and, in addition, a small quantity of sundries.

There are also small factories turning out soap, macaroni, and candles.

On the east of the town, running first in an easterly and then in a south-easterly direction, is the Central

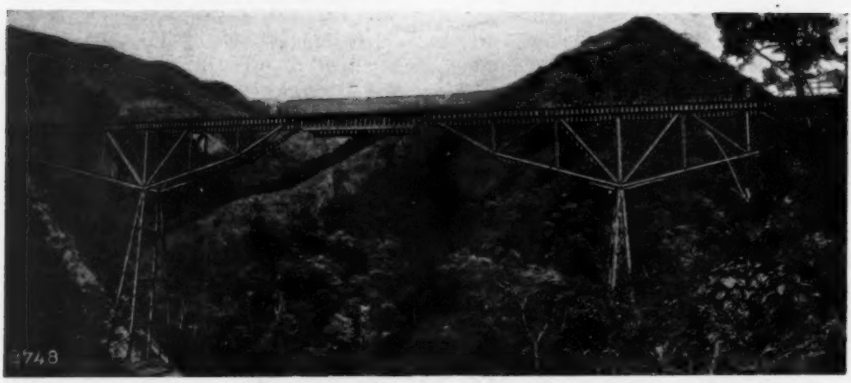



FIG. 3.—ROSARIO BRIDGE: VENEZUELA CENTRAL RAILWAY.

FIG. 4.—VIEW ON THE PUERTO CABELLO AND VALENCIA RAILWAY.

Railway. This is a British undertaking, which is eventually destined to extend to Sta. Lucia and Cua, but at present is under construction and open for traffic to kilometre 40 only. The gauge is 3 ft. 6 in., and there are curves down to 50 metre radius, fourteen tunnels and 11 kilometres of 4 per cent. grade. There is a good repair shop, and all the rolling stock is English, although for the first

**HYDRAULIC POWER INSTALLATION.**

Ten miles along the Central Railway is a place called El Encantado, where the river Guaire descends rapidly by means of a series of waterfalls, which have been taken advantage of by a local company to install an electric-power plant with two stations. One, called Encantado, has four vertical "Oerlikon" turbines coupled direct to the generators,

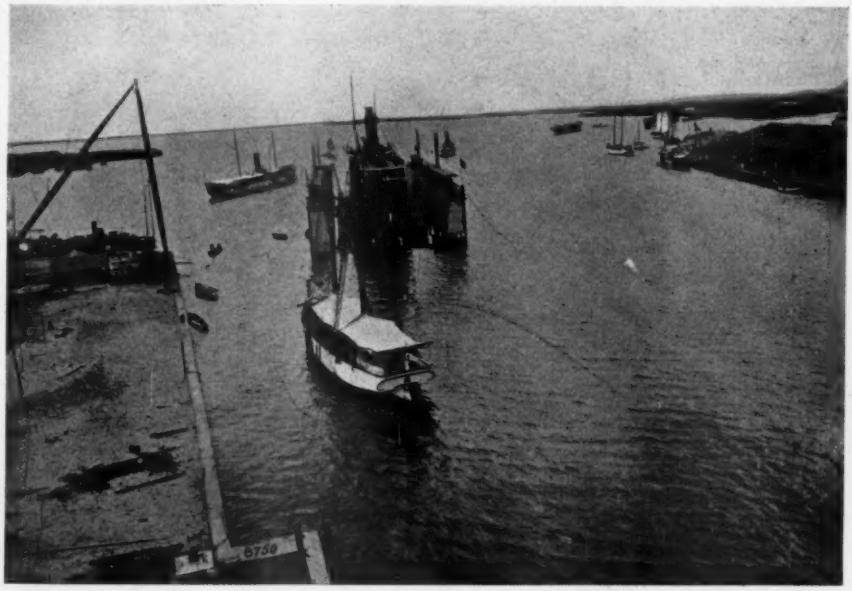


FIG. 5.—PUERTO-CABELLO, VENEZUELA. FLOATING DOCK "GENERAL CIPRIANO CASTRO," WITH THE GERMAN STEAMER "ANDES," 3,000 TONS.

10 kilometres which has just been electrified the material came from the Allgemeine Elektricitäts Gesellschaft, of Berlin.

This line contains the biggest bridge in the country, of the cantilever type, from the Phœnix Bridge Company. This structure is 46 metres high, the cantilevers being 20 metres in either direction connected by a length of 15 metres, thus making a total of 95 metres.

one set being for reserve. These generate three-phase current at 5,200 volts, fifty cycles per second, and have an output of 175 kw. each. The total fall is 34·76 metres.

The other station, called Los Maranjos, is some 3 kilometres below the first, the tail race of El Encantado being continued in an open ditch, 1 m. 50 c. wide by 65 cm. high, and with a drop of 1 m. 10 c. per kilometre, to the top of a sharp descent at an angle of 24 deg.

where it is conveyed in pipes varying in diameter from 85 cm. to 1 m., and with a fall of 154 metres, to the power-house. The latter contains two horizontal generators of 640 h.p. direct-coupled to Pelton wheels by Escher, Wyss & Co., of Zurich and London; also two exciters of 60 h.p. each.

Current at 5,000 volts is transmitted to Caracas by a double line of six No. 2 copper wires, but the company has nearly finished the construction of an independent line, which takes a different route and will convey the power at 15,000 volts, having a reducing sub-station on the outskirts of Caracas.

At El Encantado a paper factory has just been installed by a local company, with the following machinery: straw cutter, revolving spherical boiler, grinding mill, two pulping engines, paper making machine of a capacity of 2½ tons per day, a guillotine and a press, all of which machinery has been supplied by Escher, Wyss & Co. The steam for heating purposes is produced by a "Revels" patent electric boiler, made by Luige Bosilli & Co., of Milan, and capable of evaporating 130 gals. of water per hour. The plant is electrically driven, current being supplied by the Caracas Electric Power Co., which also supplies the power for the electric boiler. After various experiments with the local grasses they find they get the best results from an aquatic plant, *Typha angustifolia*, and have decided to use only this in future. The product is all thin brown wrapping paper.

The paper, rope and glass factories are the natural outcome of a few years' peace. They are all local companies with native capital, and tend to show what would happen if peace could be preserved long enough to inspire European capitalists with confidence. The tramway, telephone and Central Railway Companies are the foreign concerns which are spending money at present, all being English. The telephone company has nearly completed a circuit installation with central energy system, the wires, where possible, being laid underground in composition pipes. This company has lines stretching from Valencia to Puerto Cabello on the one side, to Guatire and Santa Theresa on the other, a distance of some 150 miles.

A cotton spinning mill is in course of erection in Caracas by the same people who own the spinning mills in Valencia.

The only jobbing repair shop of any importance in the town is one aided by the Government, containing one shaping machine, one planer, three lathes, two drills and one screw-cutting machine.

Leaving Caracas to go to Valencia one takes the Great Venezuelan Railway, the property of a German company, a wonderful piece of engineering. This line is 179 kilometres long, involving in its construction 212 bridges and 86 tunnels. The special work is all crowded into the first 75 kilometres in order to keep the grade to 2 per cent. and the curves down to 75 metres radius. The gauge is 3 ft. 6 in.—the Venezuelan standard. This railway connects the capital with the third largest town in Venezuela (Inavacaibo being the second), and joins stations with the La Guaira Railway and the Puerto Cabello and Valencia, making a circuit, and being the same gauge as the Puerto Cabello and Valencia Railway is enabled to exchange traffic with the latter.

Valencia has a steam electric light plant and a cotton spinning mill run with English machinery, cotton spinning being at present the only industry of any importance in the town. As the district round the lake of Valencia is very suitable for cotton growing, this mill ought to do very well, and at present has all its output sold for some time to come.

Cotton spinning has given rise to a new subsidiary industry, viz., the manufacture of cotton seed oil, the product being a very clean oil.

One leaves Valencia for Puerto Cabello by an English railway, 54 kilometres in length, 3 ft. 6 in. gauge, and with a stretch of 8 per cent. grade on the Abt system and provided with very good repair shops.

Puerto Cabello contains a floating dock which has been inaugurated this year in connection with a large repair shop, the whole being under Government management.

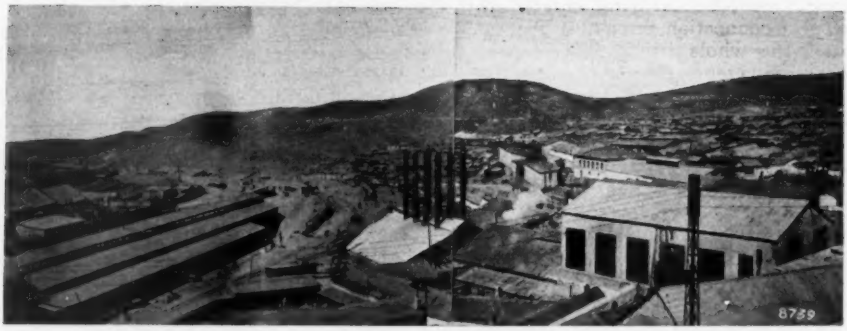
The dock is 282 ft. long by 80 ft. wide, and is divided in two sections which together can lift 3,000 tons.

Across the bay, a four hours' journey in a little boat belonging to the Bolivar Railway Co., brings one to Tucacas, the port of this railway, which goes inland to Barquisimeto with a branch at Aroa, where are the copper mines from which many tons of copper have been extracted, and where at the present moment work is being conducted on a small scale to pay the necessary expenses to look for the lode. The railway is 176⅛ kilometres long, although of only 2 ft. gauge.

### ENGINEERING PROSPECTS.

Mechanical engineering in Venezuela is in rather a backward condition. Good mechanics are scarce, and there is little demand outside one or two who get well paid. In the railway repair shops men get regular employment, and there are decent tools, but outside of these it is difficult to find much more than a lathe, although the Government maintain a technical school which is very fair and has a very good repair shop in connection with the floating dock at Puerto Cabello.

In the country there is a certain amount of agricultural machinery which mostly came from England some fifty years ago, and which is still working steadily and is seldom replaced, although a few modern Dutch machines have been brought down for coffee estates, but the present price of coffee does not permit of much extravagance in new machinery. There seems to be an idea among some of the landowners in the Tuy valley that rice would pay better than sugar, but the initial expense of machinery is a drawback.



GENERAL VIEW OF THE PULACAYO, THE LARGEST MINING CAMP IN SOUTH AMERICA.

# Bolivia: A Sketch of its Metallurgical, Mining and Electrical Equipment.

*By R. C. SHARP, A.I.M.M.*

ONE almost expects to be asked where Bolivia is, so few people having more than the vaguest idea of its geographical position, situated as it is in the heart of the South American Continent and without any seaboard. The country contains some of the highest peaks, plateaux and lakes on the Andes, and its glorious panoramas, vieing with the most beautiful of those obtained from the Alps, justly entitles this country to be called the Switzerland of South America. The climate is as varied as are its products, which range from tin, silver, copper, gold, bismuth, and antimony from the mines on its snow-capped peaks, to the rubber from its vast tropical forests.

## TIN MINING PLANT.

Few people have any conception of the advancement that has taken place in Bolivian mining methods and machinery, or that that supposed benighted land possesses to-day some of the best equipped metallurgical establishments in the world, the more astonishing perhaps when one considers the altitude, which is never less than 13,000 feet, to which height all this machinery has been hauled.

The majority of these reduction works are, however, comparatively small, the richness of the ores permitting of large products from small crushings. A striking example of this was to be seen a few months ago on the New Chocaya tin lodes quite recently developed by the writer. A trial plant was put up, consisting of a two-ton oscillating hand crusher, two hand cornish jigs, two hand square buddles and a dolly tub; in fourteen months he had got his production up to forty tons of 60 per cent. black tin per month without any other machinery.

The new works now just about ready to run contain a 50-h.p. suction gas double cylinder engine from the Deutz Gasmotoren Fabrik, of Cologne, a No. 4 "Gruson" ball mill, automatic

jigs, "Ferrari and Wilfley" tables and round cornish sweep buddles. To complete the equipment an electric light installation as well as one of the Ropeways, Ltd., company's lines is already being installed for bringing down the ore from the mine. Most of the larger tin mines, however, such as

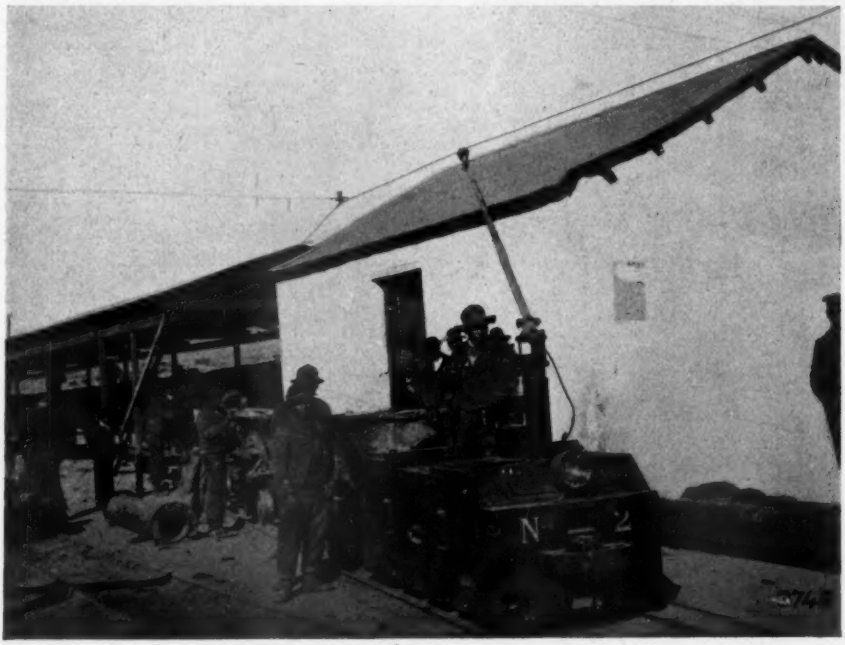



FIG. I.—ELECTRIC MOTOR WITH ORE TRUCKS IN PULACAYO ENTERING THE MINE.

Huanuni, Llallagua, Abicaya, Tasna, Chorolque, Pasna, Oruro District, Quimsa Cruz and others boast of far larger and really splendidly equipped floors. They are all connected up with their respective mines by first class automatic ropeways, the majority of which have been supplied and erected by Ropeways, Ltd., of London.

### MOTIVE POWER FOR MINES.

The most popular and convenient form of motive power for these establishments is undoubtedly the gas suction plant, the only real drawback being that due to climatic conditions at this great altitude. A 100-h.p. engine will only develop about 70 h.p. In spite of this such a plant is found to be cheaper than steam, as the cost of coal in most cases runs up to £8 per ton. Petroleum engines have been experimented with, but they soon gave way to the anthracite gas suction plants, nearly the whole of which have been supplied by the above German firm, the double cylinder type being most suitable for transportation.

The crushing machinery generally consists of stamps, rolls, and ball mills of French, German and English make.

Tin concentration is carried out by "Ferrari and Wilfley" tables, vanners and automatic jigs for the roughs, while for slimes "Acme" and other types of

FIG. 2.—GIANTS AT WORK: GOLD GRAVEL BANKS, CHUQUIAQUILLO, LA PAZ, BOLIVIA.

FIG. 3.—UNLOADING STATION OF ROPEWAY, CHORALQUE TIN MINES, OVER 16,000 FT. ABOVE SEA LEVEL.
Note wood frames now replaced by steel girders in Ropeways, Ltd., latest Bolivian plants.

Cornish round tables are almost exclusively used.

### HYDRO-ELECTRIC GENERATING STATIONS.

Electricity as a driving power for machinery has come to the front most successfully in the case of the Huanchaca Company's silver mines in the hill sides, at times crossing small rivers and ravines in a large pipe line.

The power of the present installation is 2,200 h.p., disposed in four units of 550 h.p. each.

Each unit consists of a horizontal turbine and a three-phase alternator generating at 3,000 volts, and a periodicity of 25.

FIG. 4.—SCREWING DOWN THE LAST OF THE RAILS OF THE NEW ARGENTINE RAILWAY TO BOLIVIA.

Spikes are not used, the wood sleepers being too hard.

Pulacayo. Previously steam had been almost exclusively used, but the power for driving machinery of every description is now supplied by a central hydro-electric generating station, situated at about 100 km. from the mines themselves.

This electric station is run by the waters of the River Cagua by a fall of 102 metres, obtaine by means of a side canal of about 12 km. in length, cut in

The 3,000 volt current is stepped-up to 25,000 volts by transformers of the oil insulated water-cooled type, and is transmitted to the mines at Pulacayo by a triple-wire conductor of 30 sq. mm. section carried on metallic posts.

At the mine sub-stations the current tension is reduced to 3,000 volts, power being afterwards utilised in the various works at varying voltages for driving the winches, cages, pumps, ventilators,

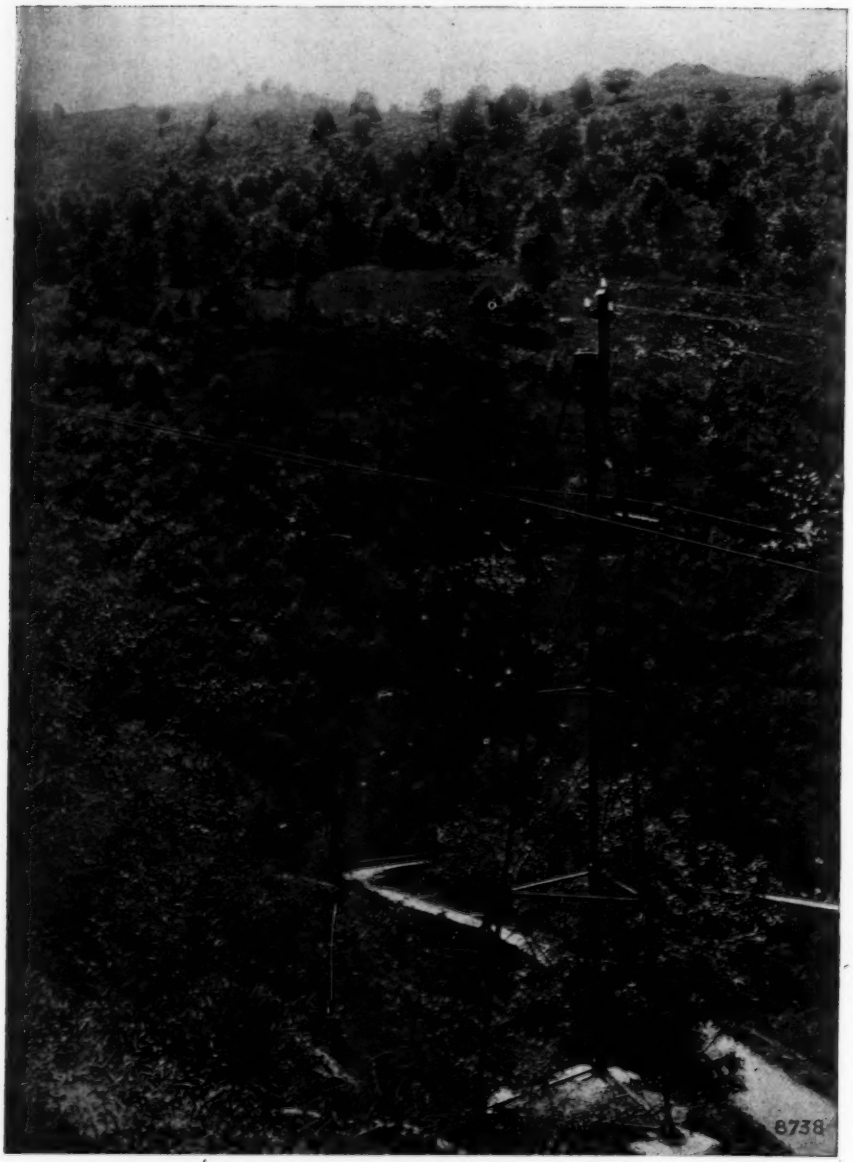



FIG. 5.—TYPICAL "BOXHEAD" TYPE LINE USED IN BOLIVIA.

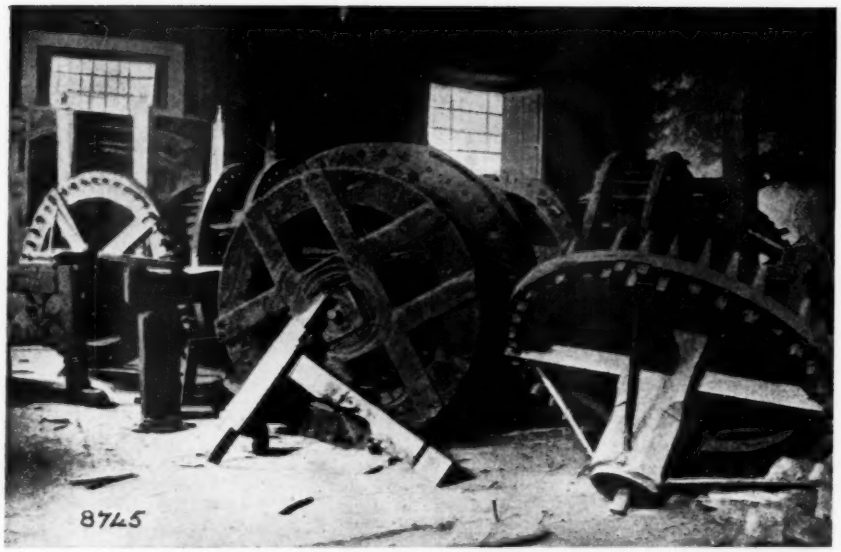



FIG. 6.—ANTIQUE MACHINERY OF THE MINT IN POTOSI

air compressors and the auxiliary motors. At 120 volts a portion is used for the lighting system.

Moreover, at 550 volts, it supplies the electric locomotives which draw the ore trucks through the tunnel from the head of the main shaft, and at 120 volts the exciter of a steam reserve alternator of 1,000-h.p.

Owing to the acute atmospheric phenomena during the rainy season at this great height (about 14,000 feet) interruptions to the development of the mine and continuous working of compressors are common. To guard against this as far as possible, a very careful installation of lightning arresters has been carried out.

Furthermore, two iron wires were placed over and parallel with the live wire, grounded at frequent intervals over a distance of some 30 kms. along the most exposed part of the line.

Such are the general outlines of this electric installation, which is working to the entire satisfaction of the company.

The whole of the plant was brought out from France, and erected by a staff of French engineers and mechanics.

As another example of an hydraulic installation I refer to the fine Californian giants erected on the Chuguiaquillo gold gravel banks near La Paz. The latter city, the now recognised capital of Bolivia, as well as most of the other larger towns, is now well furnished with electric light, the power being supplied by a hydro-generating station near the city.

### POTOSI MINING CAMP.

Potosi, the oldest mining camp in Bolivia, presents curious phases of the general improvement in mining machinery. The works as well as the city are well supplied with hydraulic power, the water being obtained from a series of lakes, expanded and augmented by large dams, which were constructed by the Indians under Spanish engineers 200 years ago. The object of these lakes is to catch and store the water that falls during the short rain season. The reduction works are situated in a

ravine one below another, each utilising the fall proportioned to it before passing on the water to his neighbour below. Tin smelting is the principal industry in this district, and one sees the old-fashioned furnaces as used 150 years ago working side by side with the modern water jackets. The fuel for these furnaces is wood charcoal, and is brought in and sold by the Indians for about £8 per ton.

Old-fashioned over-shot water-wheels, as well as curious horizontal wood Pelton wheels, about 10 ft. dia., may still be seen working, together with the most improved turbines and up-to-date Peltons.

Stamp batteries, too, made entirely of copper, including the shoes and dies, can be seen slowly pounding away beside the latest types of rapid steel rolls and ball mills.

Troops of donkeys are employed both inside the mines in levels and inclines bringing out ore, as well as outside for bringing it down the mountain paths to the reduction works; these will, however, gradually be superseded by the lines actually under construction by Ropeways, Limited, for Mr. Luis Soux, a wealthy French engineer and mine-holder.

### BOLIVIAN MINT.

The Bolivian Mint is situated in a fine three-story stone building in the city. The machinery actually in use is the same as that of the old Philadelphian Mint forty years ago, but judging from the excellent coins actually turned out, it certainly works as well as many modern Mints. Parts of the curious and very old machinery used previously are still preserved; the gear wheels, &c., are made entirely of hard wood and stayed together by iron bolts, the threads of which curiously enough appear to have been cut round by a file.

### GERMANY'S LEAD IN MACHINERY.

The machinery imported into Bolivia is of English, French, and American manufacture, but the greatest share of this

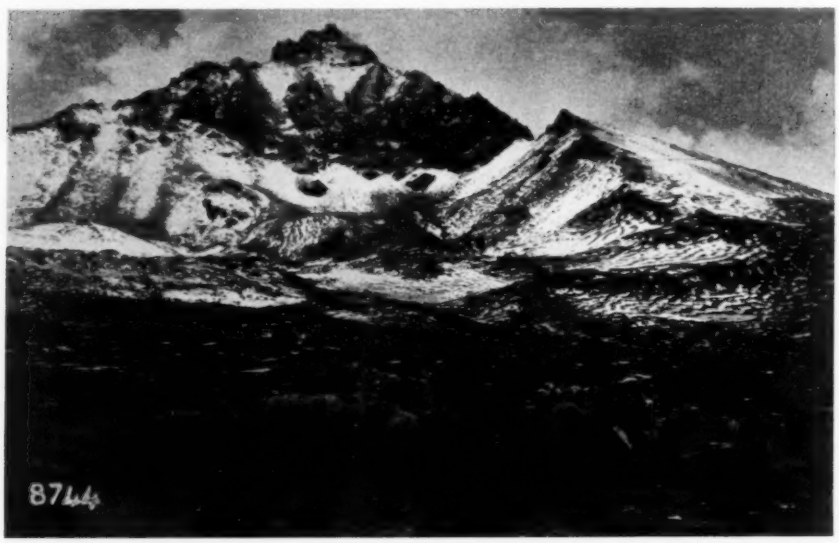


FIG. 7.—THE PEAK OF CHORALQUE MOUNTAIN, ABOUT 18,000 FT. ABOVE SEA LEVEL INDIANS LOADING SACKS OF TIN ON THEIR LLAMAS.

FIG. 8.—THE WRITER'S TIN REDUCTION WORKS AT CHOCAYAL, SINCE SOLD TO A COMPANY

trade falls to Germans. They soon pick up the language, treat their clients with courtesy, and take endless trouble to suit them; their catalogues, too, are well illustrated and carefully translated into Spanish. The Government imposes no duty on imported machinery.

### ACCESS.

The most convenient approach to Bolivia has hitherto been from the port of Antofagasta on the west coast, and is certainly still so for imports, *via* the Antofazta and Bolivia railway, but the Argentine Government railway is now complete right up to the Bolivian southern boundary. Only four and a half years ago the traveller wishing to enter on this side *via* Buenos Ayres after reaching Jujuy by rail, had the pleasure of a ten to twelve days' rough ride on mule back to finish up with. Now that part of the journey is accomplished in almost as many hours and in a luxurious train.

If the present Government's programme of railway construction is carried out by Messrs. Speyer, who have received £2,500,000 from the Bolivian Government, the country will in a very few years see its principal towns and mining centres linked together by rail.

Bolivia holds the second place in the list of the world's tin-producing countries, a place it will certainly easily retain for many years to come; what place, however, it will occupy with regard to its numerous other mineral resources remains to be seen, but it certainly offers at the present time a most interesting field to both British capitalists and engineering firms.

XUM

# Mexico.

*By T. BOLTON.*

ALTHOUGH providing a wide field to engineers, Mexico is little known to our manufacturers outside those engaged in the production of mining machinery and plant. Large sums have been spent and important works have been carried out, but the development, so far, has been largely effected by Government, and not by private enterprise, consequently the money has passed through the hands of few only, and its purchasing powers for plant and machinery has been confined to very narrow grooves. The greater part of the work for the drainage of Mexico City, the extensive harbour work at Vera Cruz, the work on the Isthmus of Tehuantepec with harbours at Coatzacoalcos on the Gulf side, and at Salina Cruz on the Pacific Coast, and the reconstruction of the railway connecting the two harbours have all been carried out by one firm, and although involving the use of a large amount of machinery and material, the influence of the money spent upon them has not been felt amongst the many in this country.

We often see it stated that Mexico is one of the richest countries in the world, and doubtless this is quite true, because not only is she rich in minerals, but the climate is so varied she can produce almost anything; but up to the present she has been almost exclusively confined to developing her mineral resources.

The country has a total area of 767,000 square miles, and 13,545,462 inhabitants, and yet there are only 46,854 square miles under cultivation, and even this area is only cultivated in a faint-hearted manner. The total exports for 1907—1908 were £24,801,801, 45 per cent. of which were silver and gold. The imports amounted to £23,336,336, but of this total £2,359,292 only came from the United Kingdom, and at the end of last year there were 13,995 miles of railway open. These figures, I am afraid, will not be very encouraging to our home manufacturers.

In all probability Mexico will eventually depend for her staple prosperity upon her cotton, jute, coffee, sugar, tobacco, alcohol, and fruit industries, and it is from the necessary extensions of railways in connection with these, and from the machinery employed therein that manufacturers must look for future business.

## RAILWAYS.

The railway undertakings in Mexico comprise some half a dozen lines of importance, and a number of small lines owned privately or by companies. Of the former the most important is perhaps the Mexican Central, whose system traverses the centre of the country, running from Mexico City to Ciudad Jaurez on the United States frontier, with branches to Saltillo, Monterey and the port of Tampico on the Gulf of Mexico, the latter passing through the important mining town of San Luis Potosi, noted for the possession of one of the most extensive silver-lead reduction works on the North American continent.

Other important branches to Guanagriato, Guadalajara, Tuxpan, Manzanilla and Balsas, bring up the total mileage of the system to over 6,000 km. The branch to Balsas from Mexico City is to be eventually extended to the Pacific ports of Sihutanejo and Acapulco.

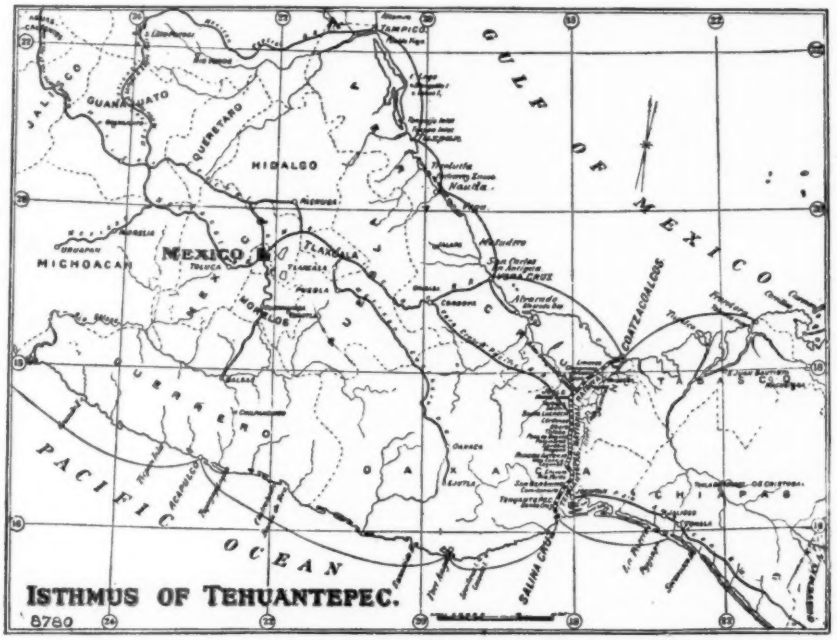
The National Lines of Mexico include the National Railway of Mexico running from Laredo, on the United States

frontier to Monterey and Mexico City, the Mexican International Railway and the Texas Mexican Railway, with a total length of something over 5,000 km. The important harbour of Vera Cruz is served by this system.

An important enterprise has recently been organised in connection with this port, the object of which is to take over the handling of all traffic within the terminal district of Vera Cruz, and to maintain and operate all warehouses, piers, yards and tracks in the terminal district, as well as a passenger station common to all lines. The company will take all goods from shipside, load them into waggons, and turn them over to the various railways.

It is proposed to spend a sum equivalent to £600,000 in plant and buildings, which will include a two-storied passenger station, 330 ft. long by 135 ft. wide, with four covered platforms, 600 ft. long; two custom-house warehouses equipped with hand and electric power; bonded warehouse, engine house and a machine shop, 150 ft. long by 60 ft. wide. A complete system of electric lighting is also to be installed, and what is gratifying to learn is, that a large part of the material required is to be ordered in Great Britain.

The other principal lines comprise the Mexican Railway of 424 km. from Mexico City to Vera Cruz; Mexican Southern, 367 km. from Puebla to Oxaca and Ejutla, and the Tehuantepec National Railway 338 km. crossing the isthmus from Coatzacoalcos to Salina Cruz on the Pacific. The latter railway, which is destined to become perhaps the most important in the country, has recently been re-constructed by Messrs. Pearson & Sons, the work involved being of a heavy character owing to the numerous rock




MAP OF THE TEHUANTEPEC NATIONAL RAILWAY.

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PIERS, VERA CRUZ HARBOUR.

cuts and bridging of rivers and chasms. Particular interest attaches to this line in that oil fuel is largely used on its locomotives, oil being found to be about 30 per cent. cheaper than coal or wood. The company at present obtains its oil from Beaumont, Texas; it is loaded on to tank steamers at Port Arthur, Texas, and is delivered at Coatzacoalcos, where the company has a large steel storage tank, of a capacity of 1,500,000 gallons, from which it is distributed to smaller supply tanks along the line, each having a capacity of 6,500 gallons. Before long it is expected that the locomotives will be burning oil obtained from local oil wells, and the stationary boilers in the company's shops at Rincon Antonio are already burning oil from the isthmus. The railway was formally opened for traffic in January, 1907, and up to December of that year carried 350,000 tons of freight. Little or none of this, however, was from the United Kingdom or Europe.

The great undertaking of making a safe harbour and docks at Salina Cruz is nearly completed. The breakwaters forming the outer harbour are finished, and the dredging of the inner harbour will be completed at the beginning of 1909. Two thirds of the wharfage and warehouses is finished and in use. The dry dock will probably be opened in October, 1908.

The area of the outside harbour is 130 acres. The inner harbour will be dredged to a depth of 33 ft. The total length of the dry dock is 675 ft., width 100 ft., and depth of sill 36 ft. 6 in.

Several new lines are in course of construction, including the Morelia and Tacambaro Railway of 225 miles; an extension of the Southern Pacific from Guaymas to Guadalajara, about 800 miles, and on the Southern Pacific

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system extension of the Yaqui River, Cavanea and Pacific Railway which is to connect with the main line of the South Pacific in Anjona and run in a southerly direction to connect with the coast line.

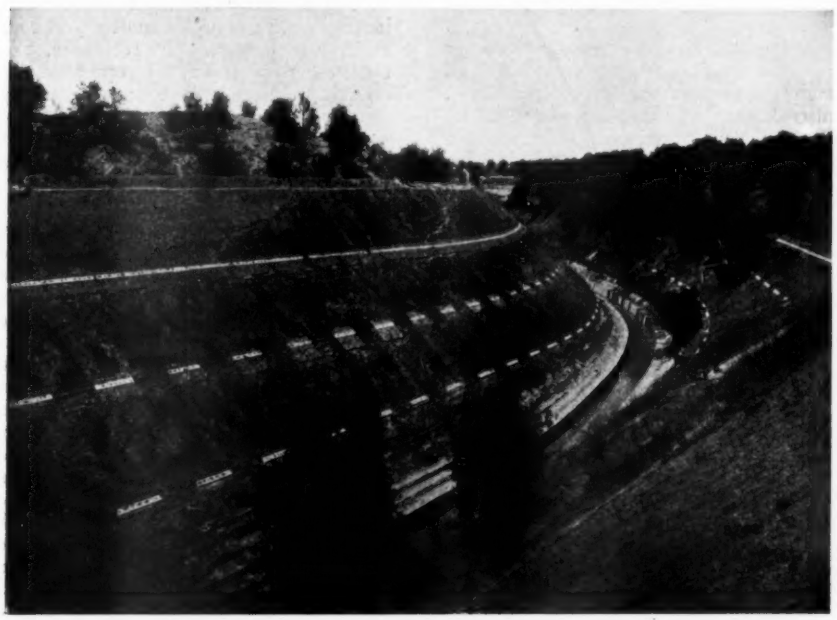
### HYDRO-ELECTRIC POWER.

Another branch of industry which some attention has been given to lately is the utilising of the natural water forces of the country for motive power. This is a move in the right direction, and no doubt there is a great future for the hydraulic and electrical engineer, and for manufacturers of hydro-electric plant. Fuel for motive power will always be a serious factor in Mexico. At present she does not feel the position so acutely, because she is falling back upon the vast resources of the forest, but the timber near the line of communications is being rapidly consumed, and it is not only becoming more difficult to procure, but it is also becoming too expensive for ordinary enterprises necessitating motive power; hence it is that capital and enterprise are centering their attention upon the possibilities of the water power to be obtained in the country

Some 75 miles to the south-west of Mexico City is situated a very rich mining district including the mining camps of Temascaltepec, Sultepec and Zecualpam. Much of the wealth of the Montezumas came from these mines, and in recent years much capital has been devoted to their working under modern and scientific methods, but the scarcity and high price of fuel has been the chief obstacle to large development.

Flowing by Temascaltepec, however, is the Rio Verde, which offered splendid opportunities for power development.

The use of this water was recently granted to a company who have just completed the installation of the first of



NORTHERN EXIT OF THE 6½-MILE TUNNEL DRAINAGE OF MEXICO CITY.



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several proposed power plants for furnishing energy to the above mines. Power is furnished at machine voltage to Temascaltepec, but for Sultepec and Toluca a transmission line of 25,000 volts has been established. Glass insulators have been adopted on this line owing to the frequent interruptions during the stormy season caused by punctures in the porcelain insulators. At the power station are four Pelton-Francis turbines direct-coupled to Westinghouse 400 kw. generators, operating 3-phase at 2,200 volts and 60 cycles. Transformers of the oil-insulated water-cooled type step up the voltage to 25,000, which is reduced at the Sultepec sub-station to 2,200 volts. A line is under construction to Toluca, at which place it will connect with the line of the Toluca company.

In this company's generating station, which is 37 miles distant from Toluca, are three induction type 300 kw. generators, operating 3-phase at 60 cycles and 6,600 volts, the speed being 360 r.p.m. Each generator is driven by a Pelton impulse wheel, and exciting current is supplied by 40 kw. 56 volt generator, also driven by a Pelton wheel. The transmission is at 27,500 volts, stepped down for local distribution to 2,300 volts. Power furnished by this company finds consumers outside the mining camps. In Toluca is one of the largest breweries in Mexico, a cotton mill, flour mill, and other establishments, all of which now use electric energy for motor driving, and have entirely abandoned steam plants.

### ELECTRIC TRAMWAYS.

Although electric power generally is finding favour for the operation of mining and industrial machinery, tramway electrification has not taken place as rapidly as might be expected in view of the large number of populous towns in that country. The two most extensive enterprises of this character at Necaxa and Monterey are, curiously enough, controlled by Canadian interests. Monterey is an industrial centre of over 80,000 inhabitants, and owing to its proximity to the United States border contains a preponderating American population. The tramways, which comprise a length of 42 km., were originally operated by animal (mule) traction, the conversion to electrification being completed in April of this year. The rail used is 72 lbs. T section, 6 in. high, with all-wire bonds. Standard 550-volt direct-current operation has been adopted on the overhead system. The power plant, which is situated within the city, consists of one 300 kw. and one 400 kw. generator, both of which are direct connected to cross compound engines. Steam is provided by three 300 h.p. water-tube boilers with extra large grate service for burning Mexican coal. The passenger equipment consists of single and double-truck cars for city service and six inter-urban cars as, in addition to the regular traffic, the company operates a 4-mile line to a suburban health and pleasure resort.

A new electric light and power plant is now nearing completion at Vera Cruz, and amongst other improvements, the old system of tramways operated by animal traction will be superseded by electricity. This enterprise is the property of a British company, in which Messrs. S. Pearson & Son, Ltd., are interested.

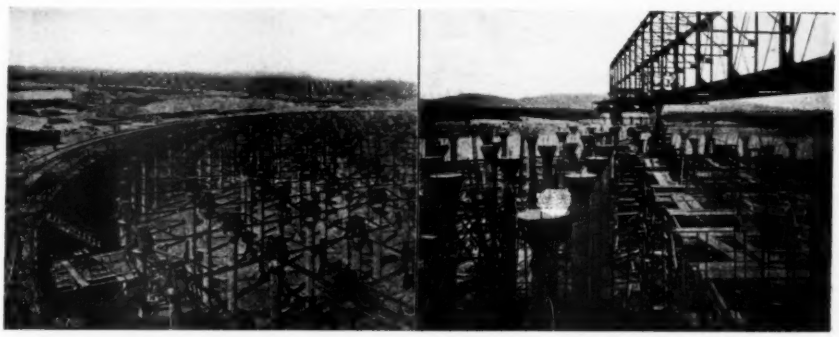
### FERRO-CONCRETE CONSTRUCTION.

Allusion has been made to the public works of the city of Mexico. There are at present in progress, in connection with the distribution system of the new waterworks, four large circular reservoirs, representing a highly interesting application of the method of armoured concrete construction.* The reservoirs are four in number and have each a capacity of 50,000 cub. m. They are circular in form, 105 m. in diameter at the top and 96 m. in diameter at the bottom. The maximum depth of water they are to contain is 7 m. The roof is to consist of a slab of reinforced concrete, 6 in. thick, supported by radial

* *Cf. Engineering Record*, Vol. lvii., No. 13.

and concentric beams, resting on cylindrical pillars of concrete, also reinforced, the whole surface to be covered with soil and converted into a public park. In the centre of each reservoir is an octagonal tower, 3 m. in diameter, reaching to the roof, from which all the primary beams radiate to the exterior. The tower, which is extended above the roof to a height of 13·85 m., contains a stairway, giving access to the reservoir.

Inlet and outlet to the reservoir is by a circular pipe also of reinforced concrete and 1·5 m. diameter, terminating in the interior of the tower.



REINFORCED CONCRETE RESERVOIRS (UNDER CONSTRUCTION), MEXICO CITY.

The columns supporting the roof are spaced at 5 m. intervals, *c* to *c*; in a concentric direction, the least span is 3 m. and the maximum 5 m. They are all hooped with steel bands, having a least section of $\frac{1}{8} \times 1$ in., riveted with two $\frac{5}{16}$ in. rivets.

A novel appliance is utilised for the rapid distribution of concrete to the various parts of the reservoir, consisting of a revolving steel bridge or crane spanning the distance between the central tower and the outer wall. This structure, which is 187 ft. in length, revolves on a pivot placed on top of two cars carried on the tower, while the outer end rests on a flat car carried on a track laid on the outer wall. On this end of the bridge two $\frac{1}{2}$-yd. concrete mixers are established, with independent steam power and elevators for delivering the aggregates to each mixer. The mixed concrete is discharged by gravity into two barrels mounted on a carriage that runs on a 28-in. gauge track along the bridge. The barrels are moved along the bridge by means of a continuous cable actuated by the 30-h.p. engine which also drives the mixers and elevator. These barrels are provided with hand-cranks and gearing by which they may be revolved, and the concrete remixed, and by which they are turned over so as to discharge into the movable hopper, placed underneath and moved to any point of delivery desired along the lower chord of the bridge. From this movable hopper, to which flexible steel or canvas pipes are attached, the concrete may be delivered into the top of any one of the columns into the girder moulds.

The total supply from the four stations is expected to amount to about 45,600,000 gal. in 24 hours.

### WOOD-WORKING MACHINERY.

Although vast stores of information regarding the timber resources of many other countries have been accumulated, it would seem, according to those intimate with the timber resources of Mexico, that the great wealth contained in its forests is unknown to many foreign timber markets. This may have been due to the difficulties of transport, but, apart from new railways, which

are just beginning to open up the country in some of the forest regions, narrow gauge and logging roads have been projected and are in construction, and, according to a recent Consular Report, there should be a good opening for the sale of saw mill and other kinds of machinery used in this class of enterprise, but it will have to be done by the man on the spot. Any attempt to try and get a share of this business simply by correspondence would only lead to disappointment and loss of time. The same report states that there is no doubt that the timber industry of Mexico, which is but in its infancy, is certain to have a tremendous growth with the advent of transport facilities.

### SUGAR MACHINERY.

The machinery, with but one exception, is of American manufacture. Formerly, machinery of British manufacture was preferred to all others, but whilst it still may lead in other parts of Mexico, it no longer holds that position in the State of Vera Cruz. It is possible that some of this trade might still be recovered by the personal attention of a representative of some of our better known sugar machinery manufacturers. The British Consul at Vera Cruz mentions incidentally that he cannot remember having met or heard of a sugar machinery salesman or expert representing British firms, having been in this district during the last four or five years. This does not mean that the field has necessarily been abandoned, as it does not follow that all commercial travellers call at the British Consulate, but the Consul believes his conjectures to be correct, and is quite sure that business might be done, especially in connection with some of the smaller sugar houses that are not yet fully equipped with modern machinery.

### AMERICAN TRADE METHODS.

The competition for the trade of the country is, and always will be very keen, especially so between Great Britain and America. Mexico City is only $4\frac{1}{2}$ to 5 days' journey by rail from the chief industrial centres of the United States, and the Americans naturally look upon the country as their own, from a trade point of view, and have, and are still, taking great pains to secure the trade. There are 15,265 Americans in Mexico, but only 2,845 British. These figures are instructive, because they explain to us that the American manufacturer does not merely send a representative casually through the country, who takes a few orders, and returns, knowing nothing about the requirements of the people. On the contrary, there are good men on the spot, who enter into, and thoroughly study matters, and not only supply what is required at the moment, but try to anticipate wants, and are prepared to supply anything at the shortest possible notice. One fact we must always bear in mind, namely, that it does not matter what it is, whether the construction of a railway, the building of harbours, the erecting of sugar mills, or tobacco factories; everything at the last is done in a hurry, because the preliminary negotiations are usually so slow, that once they are brought to a final conclusion, those concerned are anxious to make a start, and make up for lost time. It is, therefore, nearly always the firm who is ready with prices, and is prepared for quick delivery, who gets the business. The writer has seen large orders for bridges, locomotives, and other machinery and material go into the hands of the Americans simply because their agents were on the spot and had as much as possible anticipated the market.

The foundation for the future development of the country has been well established. I use the word foundation advisedly, because although there are mills for the treatment of cotton, jute, sugar, &c., breweries and factories for the manufacture of cigars, still, when we consider the size of the country and its possibilities, we can safely say that we have only at present arrived at the foundation of what will one day be an enormous trade.

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# Progress of the Work at the Panama Canal.

No public undertaking of the present time affords more features of interest than the Panama Canal, and so much has been written about the project that most readers of THE ENGINEERING REVIEW are fairly well informed, in a general way, of its scope and what is going to be done. Progress with the work, however, is now advancing so rapidly that some account of what has been and is being accomplished, is rendered necessary, although to deal with it all fully would occupy much more space than is at our disposal.

One of the most interesting books that has ever appeared on the subject is the Report of the Canal Commission for the year ending June 30th, 1907, and this together with other recent papers* will serve as a basis for a brief account of the splendid work achieved in connection with the undertaking.

Lieut.-Col. Goethals, Chief Engineer of the Canal Commission, recently reported that the total excavation for the preceding month was 1,838,486 cub. yds., making a daily average for 24 working days of 76,600 cubic yards. It is therefore safe to say that something like 120,000 tons are being hauled daily to seaward or to the dumping grounds. The French company, at their best, twenty years ago, were excavating something like 1,500,000 cub. yds. per month, so that this achievement is now being exceeded and all being well the work bids fair to reach accomplishment in 1915.

## HISTORY OF THE SCHEME

The history of the problem up to the time of the Americans taking charge in 1904 has already been fully dealt with in our pages,† but a brief recapitulation of the more important stages in the undertaking may, with advantage, be here stated.

It is eighty-one years ago since the first surveys were commenced by the Republic of Columbia to ascertain the most convenient route across the isthmus of Panama, and a report on the construction of a canal was made to the United States Congress in 1839. Numerous surveys and reports were made during the next thirty years on different canal routes, but the first to correspond approximately with the present route was that of Capt. Lull, U.S.A., made in 1875.

It was, however, in 1878 that the Panama project came prominently before the world as a question of practical politics. Two years earlier the Paris Society of Commercial Geography nominated a special committee with M. Ferdinand de Lesseps as president to examine into the question, and a syndicate was formed to organise an expedition to conduct inquiries on the spot. This syndicate obtained from the Columbian Government in 1878 a concession to construct a canal within twelve years, but was subsequently modified to the effect that the general route of the canal was to be determined by an International Congress of Engineers. It was at this congress that the opinion of M. de Lesseps prevailed that "an inter-oceanic canal, in order to meet all the requirements of commercial navigation must be constructed on a level as the Suez Canal has been."

M. de Lesseps visited the isthmus and after two years spent in preliminary surveys and plans, construction work was started. In 1887 the sea level plan was abandoned and a lock canal adopted, but in 1889 the collapse of the company occurred, the grievous details of which are still fresh in the memory. A new French company was organised and commenced work in 1894, and continued for ten years, when the Americans took over the works. Seven years ago the convention between Great Britain and the United States "to facilitate the construction" of an isthmian ship canal "and to that end remove any objection which might arise out of the Clayton-Bulwer Treaty to the construction of such canal under the auspices of the Government of the United States" was ratified. Not only did the United States become possessed of the property of the ill-fated French company but also of a strip of territory extending ten miles on either side of the canal. A Board of Consulting Engineers consisting of Americans

* A. S. Zinn, Journal Western Soc. Engrs., Nov. 1907; F. W. Waldo, Journal Franklin Inst., Jan. 1908: F. B. Maltby, Proc. Eng. Club, Philadelphia, Vol. xxv., No 1.

† ENGINEERING REVIEW, Vol. III., pp. 659–676.

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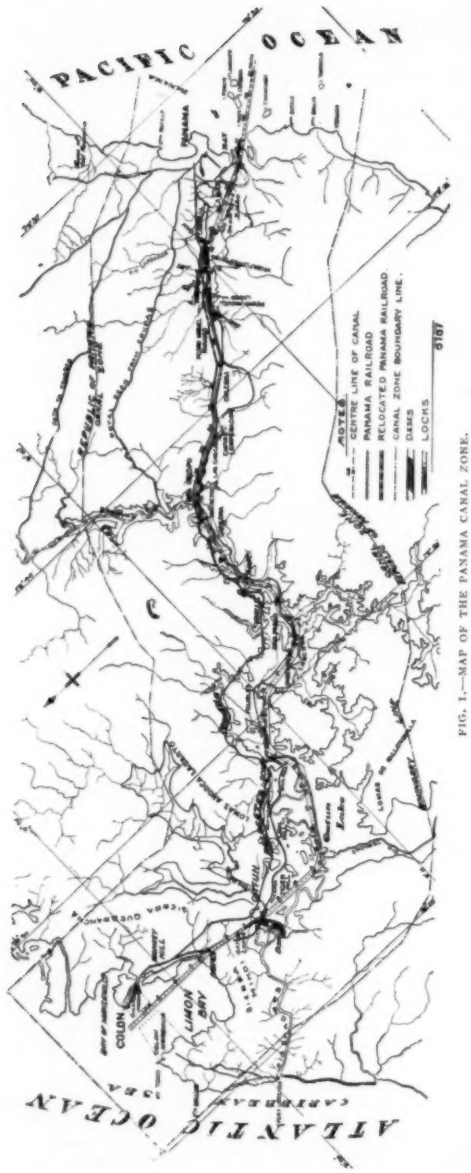


FIG. 1.—MAP OF THE PANAMA CANAL ZONE.

and one nominee each of the British, German, French and Dutch Governments reported to the Canal Commission by a majority of eight to five in favour of a sea level plan, but the Commission itself finally decided in favour of the minority report for a lock canal scheme which was upheld by the then chief engineer, Mr. John F. Stevens. The accompanying map and profile, Figs. 1 and 2, show the line of the canal, which is but a modification of the scheme proposed by the original French company.

## ROUTE.

The Atlantic terminal of the canal is at Colon where the French company, with a view of establishing a harbour there, raised a jetty projecting 1,300 ft. into the bay and rising 5 ft. above sea level. Owing to the inadequate protection afforded by this, it is proposed to construct two other breakwaters, providing for an entrance channel to the canal and for a harbour 9,000 ft. long. From the shore line the canal, 500 ft. wide, is to be continued to Gatun, at which place are to be established three locks, a great dam across the Chagres river and regulating works for controlling the heavy floods to which that river is subject. Of the lake created by the dam, about 23 miles will be navigated by ships passing through the canal. From this point through Bohio to Obispo, the depth of the channel will gradually decrease to the minimum fixed at 45 ft. The breadth will vary with the amount of excavation required to attain the minimum depth, and will range from 1,000 ft. to 200 ft. at the bottom, the latter figure being reached at the Culebra Cut, the heaviest portion of the work. The summit level finishes at Pedro Miguel at which will be established a lock of 31 ft. lift, the route passing to Miraflores at which the descent will be completed by a flight of two locks. A further length of roughly 7¾ miles brings the canal to the Pacific terminal at which it is proposed to construct a breakwater about two miles long for the protection of the Pacific entrance.

## DIVISION OF THE WORK

The work as now carried on falls into the well-defined divisions of excavation and dredging; the construction of locks and dams; municipal

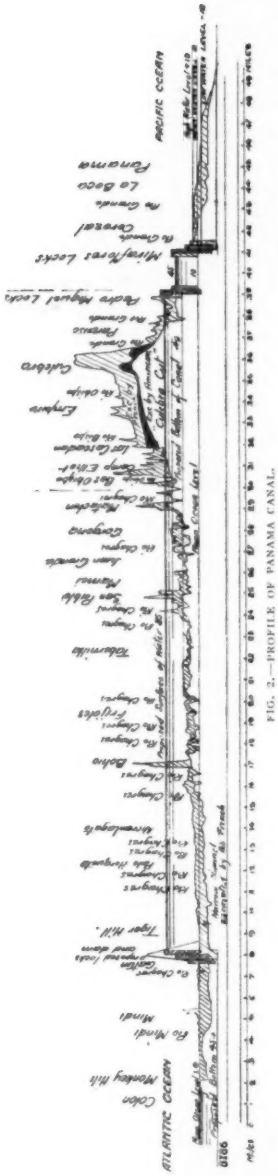

FIG. 2.—PROFILE OF PANAMA CANAL.

engineering and building construction; materials and supplies, and the construction of the Panama Railway.

The work of excavation and dredging is proceeding simultaneously at Culebra, Chagres and Colon, while lock and dam construction is going on at Gatun, Pedro Miguel and Miraflores. From the latest report of the canal commission we learn that the Culebra division extends from the Chagres River to Pedro Miguel; the Chagres division, embraced between deep water in Lake Gatun and the Chagres River; the Colon dredging division, extending from Gatun to deep water in the Atlantic, and the La Boca dredging division, taking in all excavation between the Miraflores locks and deep water of the Pacific.

*Chagres Division.*—On this division only preparatory work has at present been done, consisting of surveys and borings to determine the character and amount of earth to be removed. The Chagres River crosses the centre line of the canal twenty-three times within the limits of the division. The amount of work to be done is relatively not large, but the conditions are such as to militate against rapid progress.

Work, however, has now been commenced and steam shovels diverted from Culebra division until others under contract are delivered.

*Colon Dredging Division.*—This division consists of the Mindi and Colon districts. In the former about 700,000 cub. yds. of material in the vicinity of Mindi Hills will be removed by steam shovels, this method being more economical since the borings made indicate that a large percentage of rock is found in this locality; the remainder will be dredged. The necessary clearing and other preparations were made and excavation by steam shovel is in active progress.

In the Colon district dredging operations are in progress, the greater part in the vicinity of the dry dock slip and along the route of the old French canal as far as Gatun. The latter was done to make a navigable waterway for the transportation of the materials that must be taken to the site for the construction of the locks. The dredging fleet consisted of one old French ladder dredge, one 5-yard dipper dredge, and one 16-in. suction dredge; and for use in connection with this fleet were a tug and four old French self-propelling dump barges, known as "Clapets."

The excavation by dredges during the fiscal year, 1907, ending June 30th, amounted to 1,112,321 cub. yds., place measurement, of which 43,602 cub. yds. were

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rock; 17,000 cub. yds. of the total were removed from the canal prism, the remainder of material being from accessory works.

*La Boca Dredging Division.*—The surveys in this division, to determine the line of canal, have been completed, and dredging operations are in active progress in this division, and with a dredging fleet consisting of old French ladder dredge and one 5-yard dipper dredge.

During the past fiscal year 1,235,897 cub. yds. of material were dredged from the division, of which 64,352 cub. yds. were taken from the canal prism and the remainder from accessory works.

The machine shop at La Boca is fairly well equipped for marine work, and has accomplished much in rebuilding and repairing floating equipment, such as clapets, launches, barges, and electric cranes.

## THE CULEBRA CUT.

The Culebra division is that in which the "Great Culebra Cut" is situated, and which forms so important a part of the undertaking. The accompanying profile, Fig. 3, shows the location and limits of this cut, extending from the Rio Chagres to the Rio Grande, a distance of 9¼ miles. The south end is 8 miles from the Pacific Ocean, the Continental Divide 11, and the north end of the cut 17¼ miles. The following information concerning the work carried out on this portion is from the paper presented to the Western Society of Engineers before mentioned.

The French records show that about 12.600,000 cub. yds. of material was taken out from the Culebra Cut by the old French company, and 10,000,000 cub. yds. by the new company; or a total of 22,600,000 cub. yds. The natural surface of the ground is well defined on each side, so that it is possible to calculate fairly closely the quantity of material removed by the French within the limits of the canal prism. It is estimated that about 17,000,000 cub. yds. were taken out within these limits. On account of the old French company's alignment not corresponding in places with the American, and as the former started work for a sea level canal, their excavations in a few places are beyond the present slope line, so that their report of 22,600,000 cub. yds. is probably about correct. An approximate estimate of the quantity of material to be excavated after October 1st, 1907, gives 104.624,000 cub. yds., from which the Culebra Division will be required to move almost one-half, or 47,909,000 cub. yds. Up to October 1st, 1907, the Americans removed a total of 10,189,248 cub. yds., of which 6,360,145 cub. yds. was taken out the first nine months of this year, making an average of 706,683 cub. yds. per month. If this average is continued, it will be equivalent to 8,840,190 cub. yds. per year, or 5 years and 8 months to complete the excavation of the Culebra Cut. October reports just received from Washington show 826,891 cub. yds. removed from Culebra Cut, making an average of 718,704 cub. yds. per month for first 10 months of last year. It may take, possibly, a year longer to reinforce the side-walls with concrete, in places where there may be a tendency of the rock to disintegrate or slide into the canal.

When the Americans took charge in May, 1904, they found most everything in a wretched condition. Outside of the Culebra Division where no work had been done for 15 years the line of canal was so completely obliterated by tropical growth that one would believe no work had ever been done. The Culebra Division showed some signs of life; the French had a few excavators loading material into 4-yard dump cars. These cars were hauled by small Belgian engines and dumped on near-by dumps, the output being about 30,000 cub. yds. per month, or about the same as the Americans are now getting out in a single day.

## LIVING QUARTERS

The Americans continued the work with this poor equipment as they had no other. The first thing to look after was to provide houses and food for the men. The encampments at Bas Obispo, Haut Obispo, Las Cascadas, Empire, Culebra, Paraiso and Pedro Miguel consisted of a number of cheap frame houses for the negro labourers, and a number of better class houses for the whites. These houses had all to be repaired and painted to make them fit to live in. The above-mentioned encampments are now all beautiful little towns, with new and comfortable quarters with modern improvements. The houses are equipped with good furniture, bath rooms and electric light. The rapid advance in improvements can be best understood by referring to Empire as an example. Two years ago there were rains about every day and yet only about 500 ft. of wooden sidewalk, so that the men were compelled to walk through mud to reach their quarters; there were no street lights and no places of amusement.

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Empire is now a town of about 4,000 inhabitants, including all nationalities. Wooden sidewalks lead to all the houses; roads have been built and paved; 15 arc lights have been put into service, and most all the houses are now lighted by electricity. A large Commission hotel has been completed where all white employes can secure a good meal for 30c.; and, among numerous other improvements, are a new school house, post office, court house, baseball park, and a well-equipped Y. M. C. A. club house, provided with reading rooms, entertainment hall, billiard and pool room, gymnasium, bowling alley, refreshment room and barber shop.

Furnishing quarters and provisions for the men was one of the many problems that confronted the first officials on the job. Before any progress in the work could be made machinery and material had to be shipped from the States. Not only did it take time to get the machinery there, but it had to be assembled after it arrived, and all they had to help them put it together was a few old machine shops left by the French. All the railroad tracks were in bad shape and entirely unsafe for modern rolling stock. These tracks have all been replaced with new ties and 70-lb. rail; new tracks have been built to the new dumping grounds until there are now 122 miles of good track to handle material from the Cut, and besides the Panama Railroad has been double-tracked in order to permit the trains to be handled more quickly.

As the type of canal was not decided on until near the beginning of 1906, no definite plans for dumps could be made prior to that time. The problem was solved nine months ago; there are now tracks leading to 15 dumping grounds, with a total capacity of over 50,000,000 cub. yds., which is greater than the number of cubic yards remaining to be taken out. The largest of these dumps is at Tabernilla, which has a total capacity of 15,000,000 cub. yds. The average haul to reach it is 15 miles. The next largest dump is at Sosa Corozal, with a capacity of 10,000,000 cub. yds. with an average haul of 11 miles. The next largest is at Miraflores, with a total capacity of 8,000,000 cub. yds., with an average haul of 8 miles. The rest of the dumps are of less capacity and near the canal.

Along with all this work the building department had to rush the construction of living quarters as rapidly as possible to provide homes for the men that were constantly increasing in numbers. Reservoirs had to be built and pipe lines laid to furnish the houses as well as the steam shovels with water. The sewer and plumbing work had to keep pace with the building, as no one is allowed to occupy a house until it is connected with water and sewer pipes and accepted by the sanitary department. Further, in order to assemble the steam shovels and other machinery and look after repairs, the construction of machine shops had to be started at once.

### EQUIPMENT.

As the rolling stock was also constantly increasing, yards had to be constructed for handling the cars; coal chutes, cinder pits, water tanks, and cranes also had to be built. It was also important to build air compressors, and there are now air compressor plants at Las Cascadas, Empire and Rio Grande of 4 compressors each, each compressor having a capacity of 2,500 cub. ft. of air per minute at 100 lbs. pressure. This compressed air is fed into one line of 10 in. extra heavy pipe 9½ miles long with leads of 6 in. and 4 in. diameter running into the canal prism to drive the drills and into the shops for the machinery.

In addition to above air pipe line, there are 14 miles of water pipe and 12 miles of sewers.

The number of men now employed on the Culebra division in the mechanical department is 1,316, and will be increased about 400 men as soon as the new shops at Empire are completed.

Referring to the accompanying contour map and profile of the Culebra division, Fig. 3, beginning at the north end of cut at Bas Opispo, is located a stone crusher of 1,000 cub. yds. capacity per day. The stone is taken from the rock cut at that point, and after being crushed is used for ballasting track, and also for concrete. At Las Cascades is located a 20-pocket coal chute with gasoline hoists, also engine house, double track cinder pits, machine shops, air compressor plant, and a large railroad yard for handling cars from the Cut. At Empire, the next largest shops on the Zone are nearing completion. Repairs to steam shovels, locomotives and other machinery are made here. An electric light plant for providing lights to Empire and adjacent encampments is also located here, as well as an air compressor plant.

At Culebra are located the general offices, in which are the chief engineer and heads of departments. Between Empire and Culebra is an engine house and large planing mill and lumber yard.

At Rio Grande, near Culebra, is an air compressor plant and engine house, and railroad yards.

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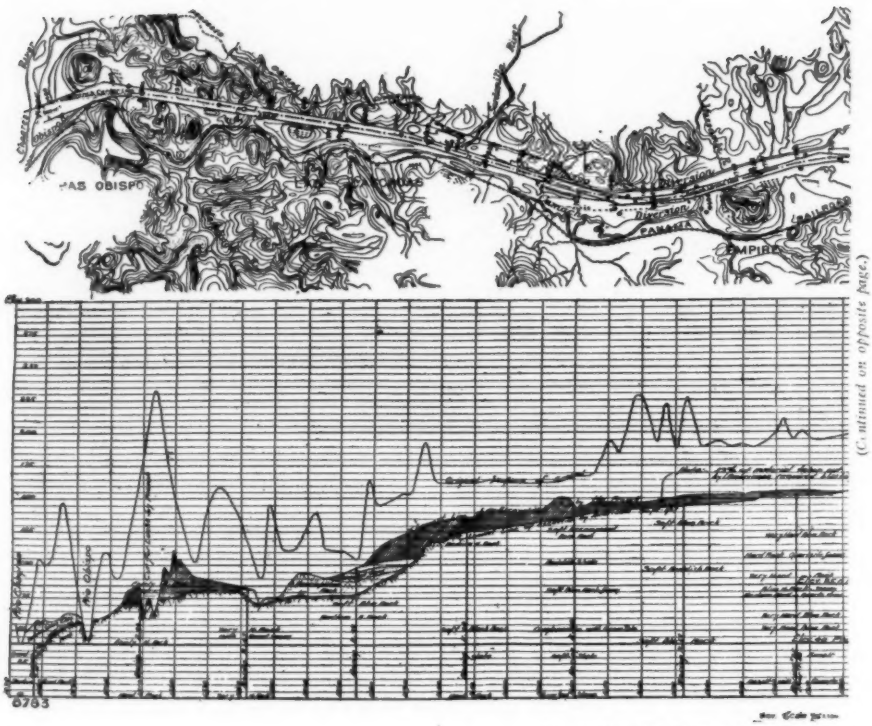



(Continued on opposite page.)

FIG. 3.—MAP AND PROFILE OF THE CULEBRA

At Paraiso are machine shops for locomotives and steam shovel repairs.

At the south end of the Cut, at Pedro Miguel, is a large clearance yard for handling work trains from the Cut. There are also a 20-pocket coal chute with gasoline hoist, a very large two-track cinder pit and engine house. Excavation is now being made at this point for the locks.

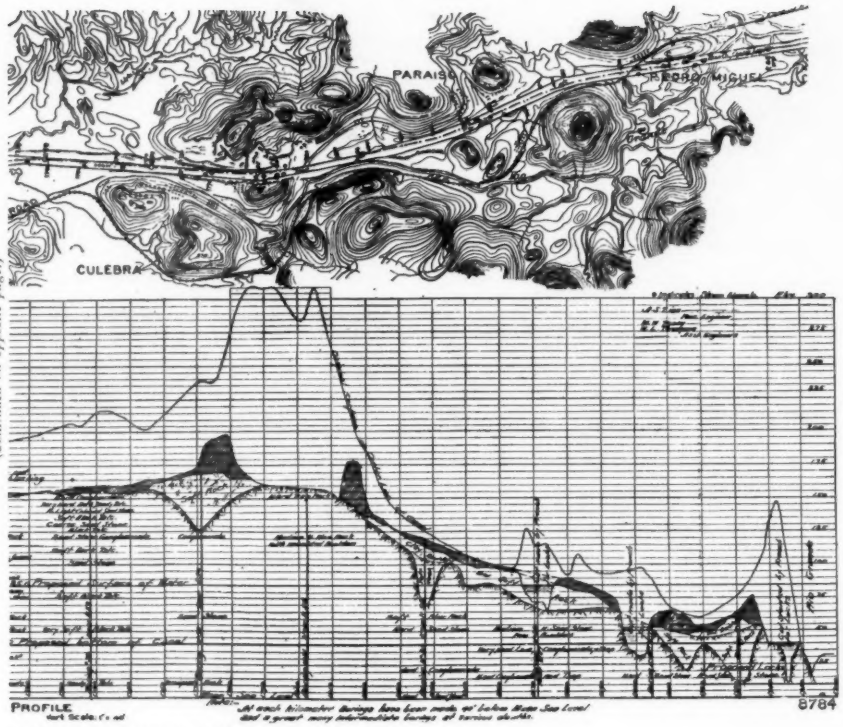
It was absolutely necessary to construct all the above-named shops, buildings, engine houses, yards, &c., in order to maintain and handle the large equipment. More steam shovels would be used but it would not be economical, besides it has been demonstrated beyond a doubt that with the present equipment the Culebra Cut can be completed in about six years or before the completion of the locks and dams outside of the Culebra division.

The total number of men employed in the engineering and construction department of the Culebra division is 10,189, of which about 950 are Americans and the balance are Jamaican and Martinique negroes, Spaniards, Italians, Hindoos and a few Panamaians.

The equipment assigned to the Culebra division consists of the following:—47 steam shovels, 17 lidgerwood unloaders, 18 spreaders, 4 track throwing machines, 224 locomotives, 2,092 cars, 126 steam and air drills, 93 mechanical (or churn) drills, 1 rock crusher, 2 wrecking cranes, 12 pile drivers, and 1 clam-shell dredge.

This equipment is never all used at the same time; there is always some equipment in the shops for repairs. During the months of August and September, the daily average number of steam shovels at work was 41, and the time lost on account of rain and other unavoidable causes was 40 per cent.; yet the average number of cubic yards loaded by each shovel per month was 18,300 cub. yds. About 53 per cent. of the material had to be blasted before it could be handled

(Continued on opposite page.)




DIVISION OF THE PANAMA CANAL.

by the steam shovels. The drilling and blasting is kept ahead of the shovels to avoid any delay.

### DRILLING AND BLASTING

The drilling and blasting is one of the important parts of the work. To give an idea how much work in this line is done in a month the following figures are given :—

| | |
|---|---|
| Steam and air drills ... ... ... .. | 53,500 lin. ft. |
| Well or mechanical churn drills ... | 32,559 lin. ft. |
| Hand drilling ... ... ... ... ... | 12,632 lin. ft. |
| Making a total of ... ... ... ... | 98,701 lin. ft. |
| Or 18·7 miles. | |

The explosives used during the month amounted to :—

| | |
|---|---|
| Dynamite ... ... ... ... ... ... | 247,550 lbs. |
| Black powder... ... ... ... ... | 400 lbs. |
| Making a total of ... ... ... ... ... | 247,950 lbs. |
| Or about 124 tons. | |

The shovels that have been used so far are the Bucyrus (70 and 95-ton type), the 70-ton type having 2½ and 3½ yard buckets, and the 95-ton, 5 cub. yds.

The highest record made so far by any one shovel was 217 cub. yds. in one day. The above average of 18,300 cub. yds. per month may seem low to those who have seen two and three times that much loaded, but the conditions under which the men work must be considered. Almost every day in the year between 10 a.m. and 3 p.m. the temperature is from 120° to 130° in the sun. The rainy season extends from about the middle of April to the end of the year. During this time it rains every day, and now and then a rain of 2 to 3 in. in as many hours. The water then rushes into the canal and floods everything ; shovels are tied up, and tracks placed in such bad condition that it is necessary to set a large gang of dippers, and the helpers around the shovels are constantly working in mud. Then there are frequent slips which cause much trouble.

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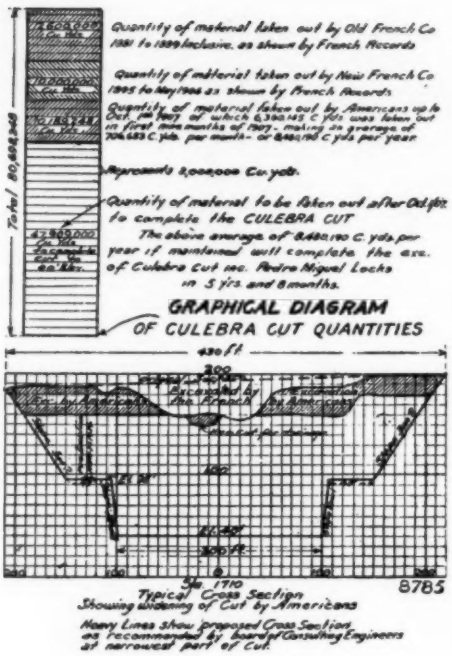
Quantity of material taken out by Old French Co 1881 to 1889 inclusive, as shown by French Records
Quantity of material taken out by New French Co 1895 to May 1904 as shown by French Records
Quantity of material taken out by Americans up to Oct 1st 1907 of which 6,380,145 C yds was taken out in first nine months of 1907, making an average of 709,683 C yds per month - or 8,480,760 C yds per year
Represents 2,000,000 Cu yds.
Quantity of material to be taken out after Oct 1st to complete the CULEBRA CUT
The above average of 8,480,760 C yds per year if maintained will complete the exc. of Culebra Cut inc. Pedro Miguel Locks in 5 yrs and 8 months.
Total 80,000,000
GRAPHICAL DIAGRAM
OF CULEBRA CUT QUANTITIES
430 ft
200
Sta 1710
8785
Typical Cross Section
Showing widening of Cut by Americans
Heavy Lines show proposed Cross Section as recommended by Board of Consulting Engineers at narrowest part of Cut

FIG 4.

## TRANSPORTING MATERIAL

Like all jobs of this kind one of the most difficult parts of it is the handling of trains in such a way as to keep the shovels busy. The transportation is handled by superintendent of transportation and superintendents of construction. So far it has been impossible to always get the empties back to the shovels in time, and you will find the same trouble very often on similar work. It is necessary to operate the trains on gradients that will not allow more than 17 to 20 wagons to the train, and to handle about 31,000 cub. yds. per day means about 2,000 loads and as many empties, requiring about 120 trains each way per day. 33 per cent. of the material is now hauled to the dumping grounds at Tabernilla, a distance of 15 miles over the Panama railroad, where delays happen now and then on account of main line traffic, and occasionally a mishap, so that it is impossible to always avoid delays. The despatchers are aided in their work by a number of telephone stations along the Cut; these telephones are also very useful for the foremen and officials to communicate with men along the Cut, and are connected with the general offices and division offices, so that they are always in touch with the work, even when in the office.

Four kinds of cars are used; large Western dumps with a capacity of 20 yds., small Western dumps with capacity of 12 yds., French dumps with capacity of 4 yds., and side flats with capacity of 20 yds. The Western and French dump cars unload at either side. The side flats have a 3-ft. permanent side-board at one side and the opposite has a 14-in. extension to floor of car, so that when the dirt is ploughed off with side plough, the material will not roll back on the rail These ploughs are pulled by 1½-in. cables connected with the Lidgerwood unloader that unloads the train in 10 minutes or less, depending on condition of material.

## DUMPING.

Most of the large dumping grounds are started by first driving a temporary trestle about 20 ft. high across low ground, and then the trestle is filled and embankment widened out as far as the wings to the spreaders will permit. The track is then shifted from trestle to the edge of the new embankment, and the same thing repeated over and over again until some of the dumps are 400 ft. wide. The track settles down into the mud so that it requires a great many men to shift the track. This difficulty has been overcome by using a track-shifting machine, invented by W. G. Bierd, general manager of the Panama railroad at that time. One of these machines with an engineer, fireman and 10 labourers will do the work of 350 men This is really the only new kind of a machine on the whole works. This machine lifts the track as well as shifts it.

The spreaders used are of the McGann and the Jordan types, equipped with air, and are made much stronger in every way than the ordinary machines ever seen in the States.

Referring again to plan and profile, Fig. 3, it will be noted from contours that the line of canal passes through a very hilly country throughout the 9¼ miles. At Station 1790 the original line selected by the French passed over a saddle at an elevation of 312 feet above mean sea level. Just east of this saddle, is Gold Hill, at an elevation of 655 feet, and west of same is Contractors Hill, at an elevation of 400 feet. The

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French cut the saddle down 152 feet; this place is known as the "Big Cut." As stated before, Culebra Cut is 9¼ miles long. At the present stage of the work it varies in depth from nothing at each end to 152 feet at Gold Hill. The deepest cut yet required to reach the proposed bottom is at Station 1775, where it will require a further cut of 130 feet. Soon after work was started by Chief Engineer Wallace, borings were made at each kilometre 40 ft. below mean sea level, and a great many intermediate borings have been made since that time at various depths, to determine the nature of the material. The results of these borings are shown on profile, and most of our work to be done hereafter will be in rock.

At each side of the deepest part of the cut the French left a barrier about 30 ft. high, as shown on profile. The first work of the Americans was to take these out so that tracks on which to haul material could be carried through the Cut. It would appear from the profile that the Americans have not accomplished very much work compared with the French. In order to make it clearer there is shown at Fig. 4 a true cross section taken at Station 1710. The Cut is now completed, as shown on cross section, to full width at top for about three-fourths the distance, and lower cuts have been started. These lower cuts will be widened the same way, until the slope lines are reached, and so on with succeeding cuts until all the material is removed. When the Cut is completed, it will vary in width from 200 ft. to 500 ft. at the bottom, with slopes as shown. On account of the water running into the Cut, a drainage channel is made with a clam shell dredge, near the centre of the canal, with side drains, so as to keep the water away from the shovels and tracks as much as possible. And this brings up the engineering problem:

### DRAINAGE PROBLEMS.

What will be done with the water when the bottom of the canal is approached? The proposed bottom of the canal, at an elevation of 40, is the same as the bottom of the Chagres River. This will probably be handled in one or two ways: In either case, a barrier will have to be left to the last moment at the south side of the Chagres River, to keep that water out, and that which collects in the Cut from side drainage could be pumped over the barrier, or a small channel could be made with a fall of about 2 ft. to the mile, commencing at this barrier near the Chagres and extending it through the canal to the south end of the Cut at Pedro Miguel, where the bottom of the Rio Grande is at an elevation of 18 ft., and from there the water will flow to the Pacific Ocean. The French engineers recognised the importance of keeping the water out of the canal during construction and completed most of the diversion work along the west side, the most difficult of which was the cutting of a tunnel 600 ft. long through a solid rock hill near Bas Obispo. Plans for the completion of the diversion work along this side of the canal have been approved by the Chief Engineer and work has been started. The French also started a diversion channel along the east side of the canal, and it was their intention to carry it across the canal near Las Cascadas in a steel aqueduct. Plans have also been approved for a diversion channel along the east side of the canal, to carry the waters of the Obispo, Massambrix and Sardanilla Rivers, and their tributaries, to the Chagres. The total length of this channel will be 4½ miles, of which 1½ miles is now completed. In order to carry all the water, the channel is being constructed to take care of a flow of 6,000 second feet. The last mile of the north end of this channel will be difficult of construction. A number of dykes reinforced with creosoted sheet piling will be constructed, and the whole line is made up of short tangents connected by 18 deg. curves, through a thick jungle, and the deepest cut is to be 87 feet with 95 per cent. rock.

After these diversion channels are completed, the only water that will run into the canal will be that which falls on the area between these diversion channels.

The dash and dotted line shown along the canal route represents the French centre line, and is a series of tangents connected by easy curves. This is practically the same route adopted by the Board of Consulting Engineers, except in place of curves there are angles, with a wide turning basin at each angle. There are nine of these angles in the 9¼ miles, the longest tangent being 9,532 ft. As may be noted by typical cross section, there is to be a 45 ft. berm at an elevation of 95 ft. on each side of the canal. Along the east berm will be built the new Panama Railroad. The object in placing it on that side is to avoid crossing the canal. The present old line west of the canal will be taken up as soon as the canal is completed. When the Americans took charge the French centre line was well-defined by monuments set at most of the kilometres, and along each side away from the canal were found

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a great many concrete bench marks, and they have been found accurate.

### LOCKS AND DAMS.

This department of construction embraces the Gatun locks and dam, the locks and dam at Pedro Miguel and at Miraflores.

The locks are in pairs, each, as now proposed, with usable lengths of 1,000 ft. and widths of 100 ft. The adopted project contemplates a flight of three locks at Gatun, a flight of two at Miraflores, and one lift at Pedro Miguel.

Prior and subsequent to the adoption by Congress of the 85-ft. level canal in June, 1906, borings were made to determine the character of the foundations at the various lock sites. The classification of the data so obtained was recorded in such a way as to cause considerable adverse comment, questioning the suitability of the material for the purpose. To actually develop the character of the foundations on which the locks are to rest five test pits each 6 ft. by 8 ft. were sunk to the depths of the lock walls at Gatun, two at Pedro Miguel, and one at the spillway in Gatun dam. On the completion of the test pits a board of consulting engineers made a personal examination of the material, and reported that they found that all of the locks of the dimensions now proposed will rest upon rock of such a character that should furnish a safe and stable foundation.

Since then careful borings have been continued over the entire area in order to secure a contoured plat of the rock surface with a view to the most economical adjustment of the locks to the site.

The method of filling and emptying the locks and the number and type of gates has finally been decided upon. The gates are in duplicate and of the mitre type, except that the rolling gate similar to that now in use on the Ohio River will be substituted for the duplicate set at the lower end of each summit-level lock. In addition there will be provided an auxiliary pair of gates at the lower end of each flight for use as cofferdams in case it may be necessary to pump out the locks, and it has been determined tentatively to adopt a swing-bridge type of dam for emergency use. The designs for the locks and gates are progressing satisfactorily.

Early in the year an important revision of the plans for the locks near the Pacific terminal was decided upon, which will result in considerable economy, and will place the locks in a much better defensive position from a military point of view. The earlier plans provided for the construction of two large dams, one the La Boca-San Juan, a mile in length, the other the Soza-Corozal dam, a mile and a quarter long. These structures would have formed a lake, two miles wide and four miles in length, and would have necessitated the relocation of the Panama Railroad and the building of a spillway from Soza Lake to the sea.

The new plan provides for the construction of a single dam at Miraflores, only half a mile long, in which will be built the two locks, by which ships will be raised from sea level to the 55-ft. level. A channel 500 ft. wide will lead from the locks to the Bay of Panama, and this channel will lie in material that can be excavated entirely by dredges. Another advantage of the change is that the Miraflores dam will be founded everywhere upon rock, which the numerous 6 by 8 ft. test pits have shown to be present throughout the whole site. The change will also lead to some economy of time in transit, since ships will be able to steam at good speed through the 500 ft. channel, direct from the sea to the locks.

### GATUN DAM.

This, the crucial feature of the whole scheme, has recently been changed in cross-section, the upstream slope being made more gradual than that originally proposed, as shown on the accompanying profile. The method of building the dam and filling the lake is thus explained in the Canal Record :—

The total length of the dam is about 7,700 ft. from the locks on the north-east to the hills on the south-west. At about its middle point there is rising ground, now known as Spillway Hill, where the regulating works are to be built. It is proposed first to dig a channel about 300 ft. wide through Spillway Hill, the bottom of it to be at sea level or thereabouts. The Chagres River will be passed through this channel during the construction of the dam across the valleys on either side of the hill. As soon as the proportions of the dam abutting on Spillway Hill are high enough to hold from 50 to 55 ft. of water in the lake it is proposed to build across the channel through Spillway Hill a concrete dam high enough to hold the lake at this level. This will be done to facilitate the work of dredging in the Chagres Division. During the dry season following the completion of this dredging the dam across the channel through Spillway Hill will be brought to its full height, and a permanent spillway constructed, which will include the necessary regulating works, by means of which the

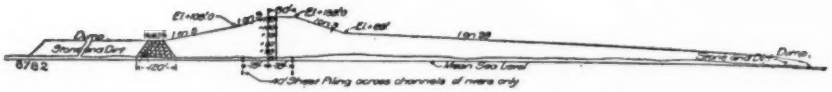


FIG. 5.—CROSS-SECTION OF THE GATUN DAM, PANAMA CANAL.

surplus water of the lake will be passed down to the level of the sea.

Preparations will be made for closing the channel through Spillway Hill before the Chagres is turned into it, and all closures will be accomplished during the dry season, thus enabling the Chagres to form a lake to the height of the dam across the spillway channel during the following wet season. It is considered probable that Gatun Lake will not be allowed to fill to the height of 50 or 55 ft. until the upper end of the lock at Gatun has been completed and the upper gates have been erected. If this plan of procedure is carried out and the progress of the work comes up to anticipation, the upper portion of the locks at Gatun will be completed before the dams are high enough to permit the creation of the lake at 50 to 55 ft. elevation. This lake will make water transportation available for handling large quantities of timber that will be submerged by the lake, and contracts may be let for cutting this timber, or it may be sold standing to the highest bidder. The exact capacity of Gatun Lake has not yet been known. The total amount of excavation at the Gatun lock, dam and spillway up to December 1st has been 1,136,000 cub. yds.

## Heavy Plate-Edge Planing Machine.

The accompanying illustration is that of a heavy plate-edge planing machine recently supplied to Vickers, Sons and Maxim, Ltd., Barrow-in-Furness, by Messrs. Smith Bros. & Co., Kinning Park, Glasgow. The machine, which is capable of dealing with nickel steel plates up to 30 ft. long and 2 in. thick, cuts the full thickness of the plate at one operation, in both directions. The girder beam is built of steel plates and angles, and, as will be seen, is provided with both hydraulic holding down rams and with screws. The table for carrying the plate is 2 ft. 6 in. wide, but six brackets 2 ft. 6 in. deep by 2 ft. wide are fitted at the back of this table to bring the width up to 5 ft. The tool holder has a vertical adjustment of 10 in., and is arranged to cant over when required so as to plane plates to a bevel, and still cut on the backward as well as the forward stroke. The main driving screw is 6 in. diameter, and is fitted with a double ball thrust bearing at one end. This screw is driven through powerful gearing by one of Vickers, Sons and Maxim's protected type constant speed motors, provided with their patented reversing device, which is self-acting from the kicker bar. The gearing is made very strong, and the teeth are cut from the solid. The motor gear brackets, &c., are all attached to a heavy cast iron sole plate, and this sole plate is bolted to the machine, making it entirely self-contained.

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HAULING TRAIN UP INCLINE ON VIADUCT NO. 6, SÃO PAULO RAILWAY.

# The Inclines of the São Paulo Railway, Brazil.

For upwards of thirty years a section of the São Paulo Railway, some six or seven miles in length, and involving a gradient of 1 in 9·75, was successfully worked by means of a rope incline on the "tail-end" system. The traffic requirements, however, increased to such an extent that the doubling of the line became necessary, and much consideration was given to the means that should be adopted for the improvement of the particular length above mentioned. Before any rope system was decided on for the duplication, the question of a locomotive line, by rack or other contrivance, was fully considered and rejected; and, in the end, the adoption of an endless rope system was decided upon, together with the attainment of an easier gradient of 1 in 12½. The new inclines are about 6½ miles in length, and rise 2,606 ft. in that distance.

To avoid excessive rope-weight the incline is divided into five nearly equal lengths, each about 1¼ miles, between which are bank-heads 142 yards in length, each having a hauling engine.

The gradient on these is level for the rising trains and 1 in 57 for those descending. Here the trains pass each other, and change from one rope to another. Passing places are also provided at the middle of each length. As will be seen from the accompanying illustration, these rails make up the track, the central rail being common to both lines. At passing places this arrangement is departed from, where, of course, double lines are provided. The merging of the three into four-line track is also shown in the illustration. The endless rope is worked as follows: At the bottom of the incline is a horizontal return wheel 14 ft. in diameter, round which the rope passes. To allow for expansion and contraction as well as the permanent extension of the cable, the return wheel is fixed on a carriage travelling on rails, laid on a track 105 ft. in length to a gradient of 1 in 8, and placed in a chamber underneath the permanent way. A chain is attached to the lower end of the carriage by a flexible wire rope and pulley blocks, with an adjustable weight of 5 tons at the ends suspended in a pit. After leaving this gear the cable is deflected to the track by two pulleys, the up-going part of it, after traversing the incline, passing, by means of another deflecting pulley, to the first motion rope-drum of the engine, and from there to the second-motion drum. It then passes to the upper fixed return-pulley, at the back of the engine-house, thence to another deflecting pulley and along the down track to the return pulley, to which it is guided by the second deflecting pulley.

The hauling engine, which is of the two-cylinder Corliss type, has, in addition to the crank shaft, another shaft, carrying a second hauling wheel and pulley. The second shaft is driven from a rope wheel on the crank shaft by a cotton rope drive, the hauling wheels fixed on both shafts being arranged to move at the same speed. These hauling drums are 14 ft. diameter, and are furnished with sufficient drums to enable the hauling rope to take four or five laps round them, passing half-round the wheel on the crank shaft and then the same amount round the second wheel. Steam is supplied by four boilers of the Lancashire type, three for regular working and one for reserve.

The ropes, which were supplied by Messrs. Bullivant & Co., Ltd., London, E.C., are $1\frac{1}{16}$ in. diameter, are of six strands, each of nine wires $\frac{1}{8}$ in. diameter, covering seven smaller wires $\frac{3}{32}$ in. diameter, and a manilla core of three strands $\frac{13}{16}$ in. diameter which had been soaked in composition, each wire strand being about $\frac{9}{16}$ in. diameter. They were guaranteed to have a breaking strength of 96 tons and to take a working load of 12 tons. The rope weighs $13\frac{1}{2}$ lbs. to the yard, and was supplied in two lengths for each incline, the splices, 72 ft. in length, having been made on the works. It is supported on sheaves fixed at intervals of 29 ft. 6 in. on the straight and 19 ft. 6 in. on the curves, the minimum radius of which is 30 chains. To prevent slip a Bullivant rope-nipper is employed.

The picking-up gear, rope nipper and brakes, are all carried on a specially designed locomotive brake-van, which weighs 30 tons, and is placed at the lower end of the train. It is equipped with a locomotive type boiler and two cylinders, 12 in. by 16 in., working at 150 lbs. per sq. in. It is carried on four coupled wheels, 3 ft. diameter, and develops a tractive force of 8,000 lbs. Steam actuated rail-grips or emergency brakes are fitted, by means of which, in case of the failure of the rope-nipper, the train may be brought gradually to a standstill.

Messrs. Bullivant & Co., Ltd., London, were the designers and contractors of the whole of the hauling plant.

The new inclines have, since their completion nearly ten years ago, been in constant and successful operation, and have been able to cope with the increasing traffic of the line.

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**Erratum.**—Page 78, right-hand column, fifth line from the bottom. For £23,000 per mile, read £9,000 per mile.



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# RAILWAY NOTES

## Railway Exhibits at Shepherd's Bush.

Those who visited the Paris (1900), Glasgow or Milan exhibitions will remember the fine display of locomotives made both by railway companies themselves and manufacturers. The railway section of the Franco-British exhibition on the contrary is distinctly disappointing, only one company showing enterprise enough to send a locomotive. That staged is a fine bogie express engine to be used for the Royal trains on the South-Eastern & Chatham system and was constructed at Ashford to the designs of Mr. Harry S. Wainwright, M.Inst.C.E., chief locomotive superintendent to the company. The engine which forms the subject of the accompanying illustration is of the 4-4-0 type with inside cylinders, Belpaire firebox and extended smokebox. Steam reversing gear is fitted as are Stone's patent variable blast pipe and spark arresting device. The leading dimensions are as under :—

| | |
|---|---|
| Diameter of cylinders ... ... ... | 19½ in. |
| Stroke of cylinders ... ... ... | 26 in. |
| Coupled wheels... ... ... ... | 6 ft. 6 in. diameter. |
| Bogie wheels ... ... ... ... | 3 ft. 6 in. diameter. |
| Boiler pressure ... ... ... ... | 180 lbs. per sq. in. |
| Heating surface in tube ... ... | 1,396 sq. ft. |
| Heating surface in firebox ... ... | 136 sq. ft. |
| Total heating surface .. ... ... | 1,532 sq. ft. |
| Area of fire grate ... ... ... | 21·15 sq. ft. |
| Centres of coupled wheels ... ... | 9 ft. 6 in. |
| Total wheel base of engine ... ... | 23 ft. 5½ in. |
| Tractive force (80 per cent. boiler pressure) ... | 17,786 lbs. |

TENDER.

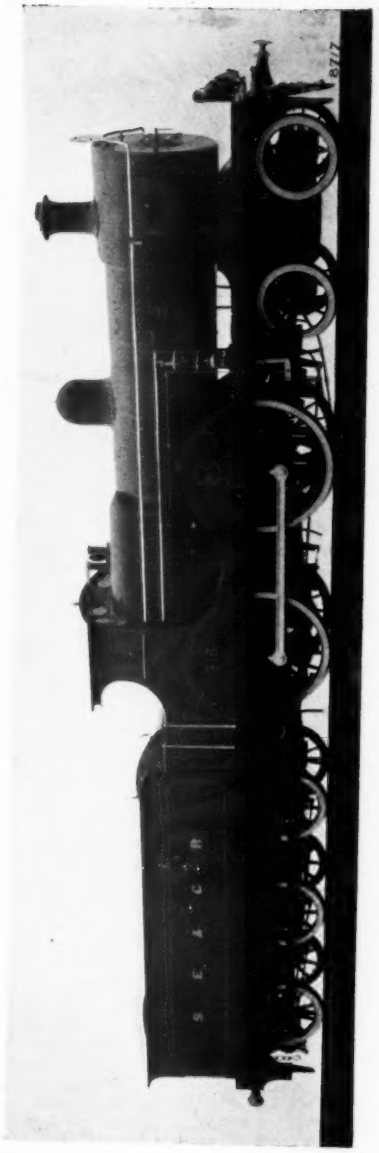
| | |
|---|---|
| Diameter of wheels ... ... ... | 4 ft. |
| Capacity of tank ... ... ... | 3,450 gallons of water. |
| Coal bunker .. ... ... ... | 4 tons. |
| Total wheel base of tender ... | 13 ft. |
| Total wheel base of engine and tender ... | 45 ft. 1¾ in. |
| Total length over engine and tender buffers... | 55 ft. 1⅛ in. |
| Total weight of engine in working order... | 52 tons 5 cwt. |
| Total weight of tender in working order... | 39 tons 2 cwt. |
| Total weight of engine and tender in working order ... ... ... ... | 91 tons 7 cwt. |

The South-Eastern & Chatham Company also show a new bogie corridor tri-composite carriage with gangway connections and a guard's compartment, designed by Mr. Wainwright for working in through service trains between the seaside towns of the South-Eastern & Chatham Railway and the Great Western, North Western and Midland systems. This vehicle, which is shown in the accompanying illustration, has the body divided into six compartments, viz., two first-class, one second, two third and one for guard and luggage at the end. A side corridor 2 ft. 1 in. wide extends from end to end of the carriage, having a division door between the first- and second-class compartments.

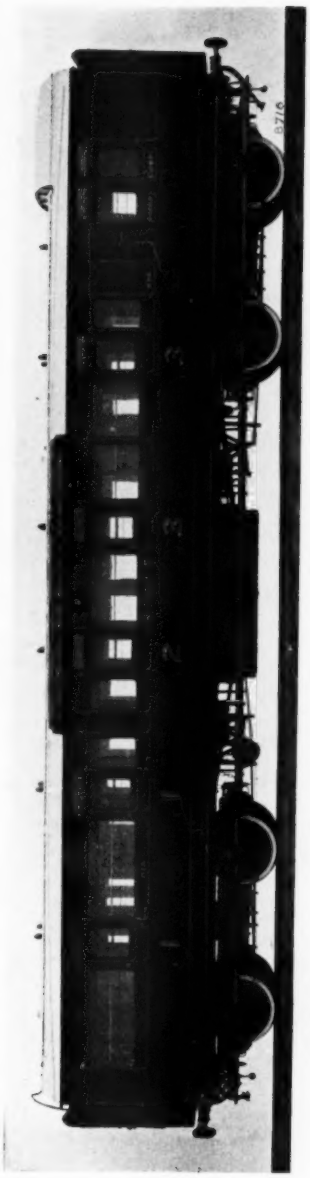
A lavatory compartment for first-class passengers is arranged at one end of the body, and that for second- and third-class passengers is arranged between the third-class compartments.

The framing of the body is of teak, and the panels and facias of mahogany. The doors are 2 ft. 1 in. wide, and are fitted with Laycock's window balances and draught excluders. The inside cabinet work of the first-class compartments is of American walnut framing with mahogany mouldings relieved with gold lines. The upholstery is covered with "Tashmere" tapestry, and the floor is furnished with Axminster rug, under which there is a ⅜-in. thickness of kork matting.

The second-class compartments have inside cabinet work of mahogany and the upholstery is covered with "Tashmere" velvet, the floor being furnished with bordered Brussels carpet rug over a ⅜-in. thickness of kork matting. The third-class compartments are finished with teak framing and bands, and birdseye maple veneered matchboarding. The upholstery is covered with "Railway Velvet" and bordered "Suberium" floor covering. The lavatory compartments are panelled with "Emdeca" and the wood fittings are of mahogany.




4-4-0 TYPE EXPRESS PASSENGER LOCOMOTIVE TO BE USED ON THE ROYAL TRAINS.




HIGH CORRIDOR TRI-COMPOSITE CARRIAGE FOR THROUGH SERVICE WORKING.

THE SOUTH-EASTERN AND CHATHAM RAILWAY COMPANIES' EXHIBIT AT THE FRANCO-BRITISH EXHIBITION.



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The carriage is electrically lighted on Stone's system of electric lighting, working at 24 volts, with two lamps of 12 c.p. each in each first- and second-class compartment, and two of 8 c.p. each in each third-class compartment. The guard's compartment and corridor are lighted by 8 c.p. lamps.

The heating is by Laycock's system of direct steam heating, with a regulating valve in each compartment. The roof ventilators are of the "Eros" pattern with regulating grids, two ventilators in each passenger compartment. The body is cushioned on the underframe with Spencer's india-rubber body cushions.

The underframe is of steel throughout; the sole bars are of bulb angle, and stiffened at each end and by flitch plates where the bolsters are connected to the sole bars.

The bolsters are formed of two steel channels, 10 ft. by ⅜ in. by 3½ in. by ½ in., framed to take the centre bogie pivot, and riveted at their ends to the angle sole bars. The headstocks are of channel section, 11 ft. by 4 in. by ½ in. The centre longitudinals are of channels, 9 in. by ⅜ in. by 3 in. by ⅜ in., and run through from bolster to bolster. The cross trimmer bars are of channels, and the end longitudinals and diagonals are of angle section, 9 in. by 3½ in. by ⅜ in. The frame is strengthened by truss rods to each sole bar and longitudinal. The buffing springs are A. G. Spencer's India-rubber cylinders, mounted in two series at each end, in the centre of the underframe, and the connection to the corner buffers is by an equalising beam, which is pivoted to the central buffer plunger. The corner buffers are A. Spencer's double buffer arrangement with an outer set of I. R. springs bearing against the headstocks, which in combination with the inner series give a high final resistance.

The bogie trucks are of pressed steel plates, and fitted with "Timmis" bolster springs, three springs to a set at each bearing. The bearing springs of the trucks are laminated, 5 ft. span, and are furnished with india-rubber auxiliary springs at their ends. These carriages are painted in accordance with the company's usual practice in lake colour, and fine lined with gold. The principal dimensions are as follows, viz.:—

| | ft. | in. |
|---|---|---|
| Length over the panels of the body ... ... | 50 | 1 |
| Width across the panels at the waist of body ... | 8 | 0 |
| Height of each doorway in the clear ... ... | 6 | 0 |
| Height from floor to underside of roof boards in centre ... ... ... ... ... ... ... | 7 | 5 |
| Length of each first-class compartment ... ... | 7 | 2 |
| Length of second-class compartment ... ... | 6 | 4 |
| Length of each third-class compartment ... ... | 5 | 7½ |
| Height from rail to top of roof of passenger compartment ... ... ... ... ... ... | 11 | 8½ |
| Height from rail to top of observatory roof of guards compartment ... ... ... ... | 12 | 6 |
| Height from rails to centre of buffers ... ... | 3 | 5 |
| Width across centre of buffers ... ... ... | 5 | 8 |
| Diameter of wheels on tread of tyre ... ... | 3 | 6 |
| Length of axles, from centre to centre of journals | 6 | 8 |
| Size of axle journals, 9 in. long by 4 in. diameter | | |
| Wheel base of each bogie ... ... ... ... | 8 | 0 |
| Distance from centre to centre of bogies ... ... | 33 | 6 |

## The London and North-Western Railway.

The London and North-Western Railway have a large open stand on which is displayed much interesting material, foremost amongst which is an electrically-controlled working model railway giving a correct representation of the company's rolling stock.

The line is laid out on a system devised by the manufacturers, Messrs. W. J. Bassett-Lowke & Co., of Northampton, by means of which the trains are operated by electric power.

While it conforms exactly to London and North-Western Railway standard practice, the model is unique as regards its actuating mechanism. The locomotives are driven and controlled electrically from the signal box as readily as if a driver were on the footplate.

The rolling stock consists of one modern London and North-Western passenger train drawn by an "Experiment" type locomotive, and one fast goods train, consisting of 10, 15 and 20-ton waggons, refrigerator vans, hopper waggons, and other types of London and North-Western goods stock.

Another interesting model is that of an electric point and signal apparatus.

This model, constructed to a scale of 3 in. to the foot, shows the apparatus which is laid down at Crewe, where about 1,000 levers on the "Webb and Thompson" electric system are provided. The point motor, taking an average of 10 amperes at 230 volts, and running at 1,500 revs. per min., performs its work in three seconds. The movement is a worm and worm wheel, and clutches are used to permit of the movement of the armature after the switch has been moved and the work done, and until the current is cut off by the lever in the signal cabin. A very complete system of detectors is employed to ensure that the movement of the lever in the cabin is not completed before each of the point switches are in their correct positions and locked, and no signal can be lowered if a point

THE LONDON AND NORTH-WESTERN RAILWAY COMPANY'S EXHIBIT AT THE FRANCO-BRITISH EXHIBITION.

switch is not correctly placed and locked in position.

The signals are worked by means of an electro-magnet taking about 3 amperes at 230 volts, the work of lowering the signal arm being performed in about half a second. When the signal is off the working current of 3 amperes is at once cut down to a so-called holding-off current of $\frac{3}{4}$ of an ampere. The wires from the cabin to the point motors are six in number, made up to form one cable of about three-quarters of an inch in diameter. This cable is laid in rough wood troughing and pitch. The wires to the signals—two in number—are similarly dealt with.

For siding points over which rapid shunting operations have to be performed, and where more elaborate blocking of a main line point is not a necessity, a magnet is used instead of the motor, the movement of the points being effected in about one second.

The object of power is primarily to reduce the manual labour of the signalman and enable him to pay more attention to the movements outside his cabin; increased speed of working, removal of obstructions on the ground caused by the numerous wire and rod connections necessitated by the present system; and finally, a reduction in the number of signalmen employed.

Mention must also be made of the specimen of London and North-Western permanent way shown.

Since 1894, the standard length of rail in use on the London and North-Western Railway has been 60 ft., of which length over 1,800 miles have been laid down. A short length of this, showing the fishplates at one end, is on view. These rails are of the British standard section, the weight per yard for the main running lines being 95 lbs.; in special places subject to heavy wear and tear, 100 lbs. is adopted.

The chairs for the 95 lbs. section weigh about 45 lbs. each, except at the joints, where both chairs and sleepers are of large size, the former weighing 54 lbs. each.

The sleepers are 9 ft. long, 10 in. wide, and 5 in. deep, which, when creosoted, weigh about 150 lbs. each. There are twenty-four sleepers for the support of each pair of 60 ft. rails. A pad of hair-felt $\frac{3}{16}$ in. thick is placed between the chair and the sleeper to take up any irregularities in the bed of the chair and give smoother running. The screw-holes in the chairs are made $\frac{3}{8}$ in. larger than

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the diameter of the screw, for the purpose of inserting a tapered wood ferrule, through which the screws are passed under pressure from the screwing machine, thus ensuring a tight fit.

Side by side with this exhibit is a section of the Liverpool and Manchester line as laid down sixty-eight years ago, with fish-bellied rails and stone block sleepers.

Several models of old coaches, locomotives and steamships owned by the company complete an attractive exhibit.

The Metropolitan Railway exhibit a motor coach as rebuilt from an ordinary coach such as is used on the steam trains. It stands on a length of track equipped with the third and return rails as in actual service.

## Railway Inspection Car.

Messrs. A. G. Evans & Co., of 13, South Place, Finsbury, E.C., are exhibiting two of the Drewry railway motor inspection cars.

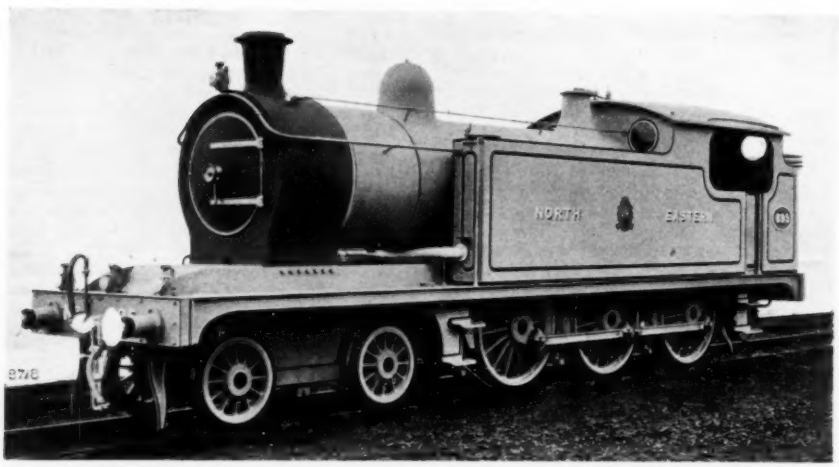
One of the cars shown is a new type they have recently put on the market, which is arranged to seat six people and is provided with a four-cylinder engine. This car has been designed to meet the demand for a vehicle of this class which will travel at upwards of 50 m.p.h.

The design of the Drewry cars has lately been much improved, and their standard workmanship is of first class order. They are provided with a very large margin of strength; and accessibility, reliability and economy are prominent features. Another feature is that they are designed entirely with a view to the work for which they are intended and are not road cars with flanged wheels added.

Every car is provided with a reverse which enables it to run equally well in both directions; the seats are also reversible. The gear change is arranged so as to make it impossible to change gear without taking out the clutch, and we believe that these cars are almost absolutely "fool-proof."

The manufacturers make only railway cars and are, consequently, able to give their entire attention to the requirements of a railway vehicle.

For railway inspection and the general use of railway officials these cars are invaluable. They make the user independent of trains, and are very much cheaper to run than a light locomotive.




One of the New Six-Coupled Tank Engines, North-Eastern Railway, as described in our May issue for service on the heavy inclines on the Scarborough-Whitby Route. The first of the batch was built with an extended smoke-box, the remainder have, however, been constructed with a box of ordinary length, as shown.

# Iron, Steel and the Foundry.

*Conducted by PERCY LONGMUIR, B.Met.*

## FOUNDRY PRACTICE.

**Problems Involved in the Erection and Equipment of a Modern Foundry.**—Mr. W. T. Hatch in a paper read before the New England Foundrymen's Association, discusses in a general way some of the auxiliaries met with in designing a new foundry. The foundry in question is that of the Brown & Sharpe Manufacturing Co.; it has been built some five years, and whilst recent enough to be still termed modern, is also old enough to have allowed for correction of some of the mistakes in the original design. Dealing with the question of power first, the foundry is equipped with both gas and steam plant, and the power generated is electrically distributed. In comparing the behaviour of gas and steam engines under foundry conditions, it is noted that the gas engine with producer gas will develop its power with a fuel consumption of about 1½ lbs. of coal per brake horse power hour including stand losses for nights and Sundays. The steam engine under similar conditions will require from 3 to 5 lbs. of coal, and in small sizes even more. The greater cost of the gas engine is an off-set to its lower fuel cost. Taking first class equipment in each case, a non-condensing steam engine and boiler plant including foundations, chimneys and auxiliaries will cost from $40 to $50 per horse power, and a gas engine and producer plant installed will cost from $70 to $80 per horse power. The gas engine therefore requires a full load and a long day in order that its fuel saving may off-set its capital charges. The opportunities for the profitable use of the gas engine will increase as the cost of coal increases, or as inferior grades are found which may be used in gas producers to better advantages than under steam boilers. In view of the imperfect condition of the art, uncertainty as to the maintenance cost and high first cost of gas power plant, its advantages over a good steam plant are much less than would be expected from a comparison of the fuel consumption alone.

These comparisons between the two classes of power have been given in order to indicate the limiting conditions which must decide the propriety of their uses. In the foundry in question, the plan is to run the gas engine to full capacity the full day and to carry the lighting and peak of the power load beyond the gas engine's capacity with the steam engine. In this way final results are probably better than could be obtained from either gas or steam power plant alone.

With the exception of compressed air the power is electrically distributed, 36 motors in sizes from 3 to 50 h.p. and aggregating 366 h.p. being installed at widely separated points. These motors are used intermittently, and the fact that the average load for operating them is only 120 h.p., indicates the large proportional time they are not in actual service. In view of the scattered location of the motors, the driving of the same machinery from continuously running shafting from a single engine would be expensive and almost impractical.

Artificial lighting of the foundry is obtained from arc and incandescent lamps, and the same current is utilised for electric current and hoists. The roof of the foundry is a modification of the saw tooth roof, and daylight is obtained from roof lights set in the northerly slopes of the roof. In this respect the author specially emphasises the necessity of admitting *skylight* instead of direct sunlight.

Until recently castings were cleaned by pickling and tumbling, but of late there has been a strong demand for sand blast cleaning owing to the better surfaces obtained. Sand blast tumbling barrels have been installed and the work done is satisfactory in both quality and quantity. Labour cost is no greater than with ordinary tumbling, but installation and maintenance costs are high. The installation

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of sand blast barrels must therefore be justified by the quality of the work done, rather than by its cost. The application of sand blast to large castings such as machine framings offers difficulties chiefly in the way of eliminating the dust. These castings are now cleaned in a room 15 ft. square and 8 ft. high, and the work is suspended from an overhead tram rail. The room is ventilated by means of a "Sturtevant" steel plate exhauster with 18 in. suction and discharge connections. The exhauster runs at 1,260 r.p.m. and gives a free circulation of air through the room.

In handling material it was soon found that any system of tracks was expensive to instal and not flexible enough in use to give good results. It was finally decided to build a smooth floor and use special trucks with large wheels and roller bearings. These trucks have platforms about 24 in. high, with wheels 20 in. diameter by 4 in. face. The wheels run on dust-proof roller bearings and with them it is practicable for one man to move from 2,000 to 3,000 lbs. of pig iron. Five years' service has proved this arrangement to be more satisfactory than any system of cars and tracks. In the heavy foundry handling is provided for by travelling cranes.

The largest crane is of 10 tons capacity and covers an area of 30 by 160 feet. It is operated from a cage and all its motions are electrical. This crane distributes the ladles from the cupola to the 8 five ton cranes which flank its side. The light foundry is framed to carry light travelling cranes of 2 tons capacity. In this foundry molten iron is handled by means of two systems of overhead tram rails each having one outgoing and returning rail with numerous crossovers, extending from the cupolas to the extreme end of the foundry. Iron flows continuously from the cupola into a mixing ladle from which it is passed to the distributory ladles and thence *via* the track to the moulding floors.

**Errors in the Design of Patterns.**—Mr. P. R. Ramp, writing in the *Founary* on the errors of designers, attaches importance to the fact that foundry difficulties are not recognised. It is true that crudely designed castings can be produced and are made daily but their production is attended with unnecessary difficulty and cost. In making high pressure castings it is more important to design them with a view to simplifying the shrinkage problem than to design with a view to simplifying the moulding problem. The latter can be handled by the founder, but as regards design he is supposed to make anything that comes in. The fact that these troubles are due to changes occurring whilst the iron is passing from the liquid to the solid state, is no part of the designer's curriculum, but they have to be dealt with daily in the foundry, hence they should be recognised in the drawing office. A series of sketches are given all of which aim at the equalisation of section so dear to the heart of the founder, and so necessary for the production of sound and strong castings.

**Semi-steel Mixtures.***—According to Mr. M. B. Smith semi-steel as now made is a successful imitation of air furnace iron, and the idea of making it was undoubtedly derived from the air furnace. In the air furnace cast iron loses a certain amount of carbon, and provided the silicon is not too low the resulting castings are grey, fine grained and of high strength. The strength is largely due to low graphite, hence if carbon can be lowered in the cupola mixture a similar metal will result. The only way to effect this is to dilute the mixture with steel scrap containing very little carbon. A good composition for semi-steel of the ordinary kind is as follows:—

| | | | |
|---|---|---|---|
| Silicon | ... | ... | 1·80 to 2·00 per cent. |
| Sulphur | ... | ... | 0·06 ,, 0·10 ,, |
| Phosphorus | ... | ... | 0·65 ,, 0·85 ,, |
| Manganese | ... | ... | 0·85 ,, 0·95 ,, |
| Graphite | ... | ... | 2·30 ,, 2·40 ,, |
| Combined carbon | ... | ... | 0·80 ,, 1·00 ,, |

A metal that will show high strength, resist wear and heavy shocks, is as follows:—

| | | | |
|---|---|---|---|
| Silicon | ... | ... | 0·90 to 1·00 per cent. |
| Sulphur | ... | ... | 0·04 ,, 0·06 ,, |
| Phosphorus | ... | ... | 0·15 ,, 0·30 ,, |
| Manganese | ... | ... | 0·60 ,, 0·70 ,, |
| Graphite | ... | ... | 2·40 ,, 2·60 ,, |
| Combined carbon | ... | ... | 0·80 ,, 1·00 ,, |

In the first analysis, with high silicon the metal will show very little more shrinkage than ordinary cast iron. The phosphorus gives fluidity, and manganese is sufficient to remove the effects of oxidation. This analysis represents a type of semi-steel largely used, and it is frequently made by adding 25 per cent. of steel scrap. The second analysis represents low silicon and phosphorus; the metal has a high shrinkage, is tougher and will stand wear and abuse better than the silicon metal. It has a low range of fluidity, must be poured very hot, and requires large gates and risers. A mixture given for high silicon semi-steel is 25 per cent. steel scrap, 15 per cent. cast iron scrap, 20 per cent. high phosphorus

* The *Foundry*.

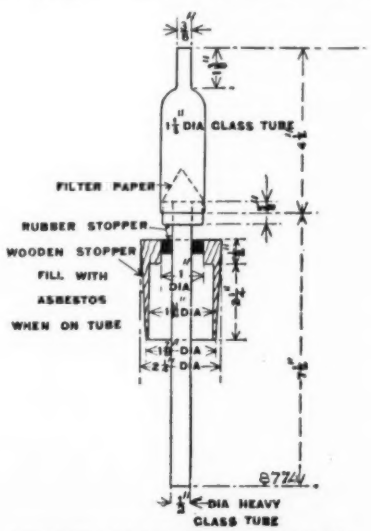
pig iron and 40 per cent. high silicon pig iron. The steel scrap may be in the form of boiler plate, structural steel or rail steel. It should be fairly heavy for thin sheet or fine clippings are oxidised before melting.

For a 10 per cent. steel mixture the melting ratio is the same as for ordinary cast iron, but with higher contents of steel the amount of coke must be increased. Much of the trouble met in making semi-steel is due to lack of heat, and the aim should always be for hot metal. After giving details as to calculating mixtures, Mr. Smith gives the following points:—(1) Do not use more than 25 per cent. steel scrap. Good mixtures are made with 10 and 12 per cent. (2) Pour with hot metal. (3) Keep the manganese high.

**Production of Malleable Castings.***—In his fourth article Dr. Moldenke discusses mixtures for malleable castings. The various materials entering the mixture include pig iron, gates, wasters, annealed scrap, steel and wrought iron scrap, borings, cast iron scrap and ferro-alloys. Each of these materials has a bearing on the finished casting and the use of any particular one is limited by its effect on the final product. Taking normal American malleable cast iron the composition will be found to run within the following limits:—

| | | | |
|---|---|---|---|
| Silicon from | ... | ... | 0·45 to 1·00 per cent. |
| Manganese ... | ... | ... | up to 0·30 ,, |
| Phosphorus ... | ... | ... | ,, to 0·225 ,, |
| Sulphur ... | ... | ... | ,, to 0·07 ,, |
| Total carbon | ... | ... | above 2·75 in the hard. |

In special cases for very small castings silicon may reach 1·25 per cent., whilst for very heavy work it may fall to 0·35 per cent. with good results. Manganese may go higher, but this is not generally advisable, in that manganese is first to oxidise in the mixture and costing money, as iron when bought simply adds to the melting loss. Further, high manganese appears to give rise to annealing difficulties. Phosphorus and sulphur represent the chief difference between American and European practice. In the latter phosphorus is as low as for acid steel castings, whereas in American irons phosphorus is required not to exceed 0·225 per cent. This is due to the fact that American charcoal irons run as high as 0·225 per cent., and as they are first class for malleable work the upper limit is as given. In the case of sulphur, Europe makes successful malleable castings with this element as high as 0·40 per cent., whereas American makers aim at one-tenth this amount, or 0·04 per cent. American makers call for low sulphur, in order that they may anneal castings to the black heart. This is impossible with European high sulphur irons, where a long anneal at high temperatures results in the removal of the carbon. The high sulphur in European malleable also accounts to some extent for the comparatively low strength when contrasted with American products. European castings are all very light, and so long as they bend and twist properly the purpose is served, and until heavier sections become the rule instead of the exception white heart and steely-looking fractures will remain the characteristic feature of European work. The author passes on to a consideration of pig-iron specifications and the various forms of scrap entering the mixture. In regard to ferro alloys, ferro silicon is the only one which should be kept in stock at a malleable foundry, and this for emergency use. Of ferro titanium, ferro vanadium, and also ferro magnesium when this comes on the market, their application is too new to give results at the present time. Passing from the materials entering a heat, Dr. Moldenke in his fifth article takes up the calculation of mixtures. These call for no special notice, but in concluding the series the author gives advice as follows:—"In conclusion it may be said that close attention to the scrap piles, the mixture requirements to make proper classes of malleable; the buying of irons to keep the minimum of




INSTRUMENT FOR DETERMINING DIRT IN BLAST FURNACE GAS.

* The *Foundry*.

metal piled up in the yard without being caught unprepared through slow deliveries, constitute the art of getting results without having to resort to the purchase of cheap irons which mean bad malleable every time. A good laboratory and, still better, a good metallurgist pay over and over again in a malleable shop, even with an output as small as 10 tons a day of finished castings."

**The Determination of Dirt in Blast Furnace or other Gas.**—The following method, reported in the *Iron Trade Review*, has been worked out by Mr. F. Brinker. A nine-centimetre filter-paper is folded so as to fit inside the large glass tube in the shape shown in the sketch; the rubber stopper on the glass tubing fitting inside the filter presses it to the side of the large glass tube, thus making a tight joint. The wooden stopper through which the glass tubing passes is hollowed out to make it more pliable, also to give more heating surface to the glass tubing, and thus prevent the separation of moisture in the tube. A little asbestos is put in the bottom of the stopper to protect the rubber cork. The stopper is placed in a $2\frac{1}{4}$ in. hole in the gas main where the sample is to be taken. The end of the tube with the filter in it is connected to an aspirator, and 1 cubic ft. of gas drawn through. The filter is removed from the tube, dried and weighed. The difference between this and the weight of the filter represents the amount of dirt in 1 cubic ft. of gas. If any dirt collects in the glass tubing on its way to the filter this must be added to the filter before drying and weighing. The filtering tube may also be connected to a gas meter which is operated by a small suction-pump, the meter running at the rate of about 3 cubic ft. per hour. By this means a test lasting several hours may be made, and a much better average obtained of the dirt in the gas. The appended illustration gives further details of the apparatus, which may be readily constructed, and is stated to yield good results.

## NEW BOOKS.

**Introduction to Metallography.** By PAUL GOERENS. Translated by F. IBBOTSON, B.Sc. (London: Longmans, Green & Co.) Pp. 210. **7s. 6d.** net.

In the March issue of this Review, we had occasion to commend Mr. Goerens' "Einführung in die Metallographie," and we now heartily welcome the appearance of an English translation. In it students have a ready and reliable guide to the domain of physical chemistry, in so far as it affects metallographical studies. The translation is remarkably effective, and Mr. Ibbotson is to be heartily congratulated on the successful achievement of a difficult task.

To all intents and purposes the translation is a second edition of the original, for the author has largely re-written the section on iron and its alloys. We strongly recommend the book, and whilst not necessarily endorsing all the views advanced, still think these views worthy of careful and earnest attention.

**"Les Aciers Spéciaux."** By L. RÉVILLON. (Paris: Gautier-Villars).

M. Révillon has for the most part abstracted various papers on the influence of special elements on steel, and endeavoured to present them in orderly sequence. As a convenient record of work done in this direction, the work will serve a useful purpose, but beyond this one can hardly commend it. The selection is not as wide as it should have been, and the matter given is lacking in many essentials.

**The Electric Furnace in Iron and Steel Production.** By JOHN B. C. KERSHAW, F.I.C. (London: The Electrician and Publishing Co.) Pp. 68. **3s. 6d.** net.

After a brief historical introduction the author passes on to a consideration of the recognised types of furnace, and the process followed with each. Separate chapters are devoted to the "Héroult," "Keller," "Kjellin" and "Stassano" furnaces and processes. The sixth chapter, comprising miscellaneous processes, includes descriptions of the "Conley," "Galbraith," "Gin," "Girod," "Harmet," "Hiorth" and "Ruthenberg" furnaces. Practically every process introduced with a reasonable chance of success is described. The author is seen at his best in the concluding chapter of the book dealing with yields and costs. Here in well-considered words the author draws attention to the difference between figures based on estimates and those based upon actual trial. Results obtained from the various processes are given and discussed, the chapter forming a valuable contribution to the commercial side of electro-thermic smelting.

**Practical Metallurgy.** An Introductory Course for General Students. By THOMAS TURNER, M.Sc., A.R.S.M., Professor of Metallurgy, University of Birmingham. (London: Charles Griffin & Co., Ltd.) Pp. 104. Price **3s.** net.

# Machinery, Appliances and Processes.

The Editor invites advance particulars, drawings, blue prints, photographs, and any data that will enable him to publish an adequate description in these columns of any new work, machinery, or installation, possessing special features of interest. The cost of publication and engraving is borne by us, and no compensation is expected. In the endeavour to produce a really high-class and technically valuable machinery section the Editor seeks the co-operation of engineers and manufacturers.

## Grain Handling Plant at Bahia Blanca.

Amongst the notable British engineering firms having an extensive business connection with South America an important place must be assigned to Messrs. Spencer & Co., Ltd., of Melksham, Wilts., the well-known specialists in machinery and appliances for the handling of grain in bulk and in sacks.

This company are now occupied with a large and important installation of transit silos or elevators erected at the port of Bahia Blanca for the Buenos Aires Great Southern Railway Co. As is well known, the amount of grain exported from the Argentine Republic has been yearly growing by leaps and bounds, and the relative increase in shipment is probably greater at the comparatively new port of Bahia Blanca than elsewhere. It, therefore, became a necessity for the Buenos Aires Great Southern Railway Co. to very largely increase their facilities for handling the immense quantity of grain which they bring into this port from their up-country stations, in order to secure rapid and economical means of unloading their grain trains and of transferring the produce to the vessel. It was accordingly decided that the best means of dealing with the problem was to build a large steel mole projecting into the harbour on to which their sidings would run, along both sides of which vessels could be moored, and to erect on this mole two large steel transit silos or shipping elevators equipped with the most complete and up-to-date appliances for handling the enormous bulk of material required to be dealt with.

The contract for these elevators with all the grain-handling machinery, motors, and auxiliary appliances was accordingly placed in the hands of Messrs. Spencer & Co.,

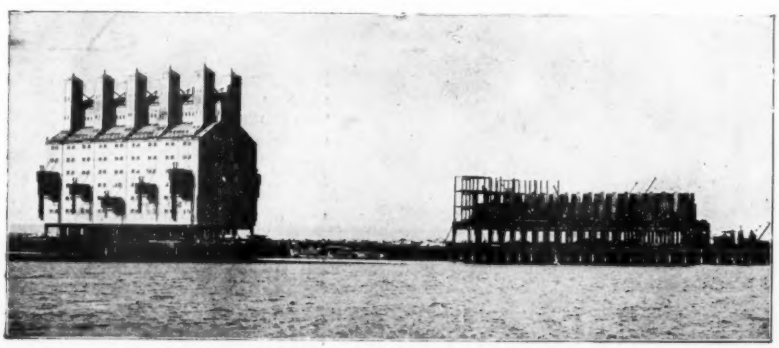


FIG. 1.—STEEL TRANSIT SILOS IN PROCESS OF ERECTION AT BAHIA BLANCA.

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FIG. 2.—SIDE VIEW OF TRANSIT SILO.

working under the direction of the consulting engineers to the railway, Messrs Livesey, Son, & Henderson, of London.

The steel mole and one of these elevators has already been completed and has recently been put to work, the whole plant having started off without a hitch of any kind. This is a most satisfactory result in view of the very large amount of machinery involved, and must be highly satisfactory to all concerned. The second elevator is now rapidly approaching completion.

Some idea of the size and appearance of these huge plants, which are probably the largest and most complete of their kind in existence, is given by the illustrations, Figs. 1 and 2, which are reproductions of photos taken during erection. It will be seen that the elevators span over practically the whole width of the mole, and the various lines of railway run underneath them.

Each elevator is equipped with ten large hoppers under rail level, five on each side, and the grain coming from up country in large hopper-bottomed waggons is shot directly into these by simply running the waggons over the hopper and opening its discharge outlets.

Connected with each hopper is a bucket elevator of 150 tons per hour capacity, which takes the grain up to the top of the building, passes it through a weighing machine, which deals with 20 tons per weighing, and then on to a conveyor, which deposits it into any one of the seventy-two steel hexagonal bins which are fitted up in the centre of the building.

FIG. 3.—FLOATING ELEVATOR AT BAHIA BLANCA.

If desired, the grain instead of going into the bins may be led direct to one of the loading-out conveyor bands, of which there are seven on each side of each silo, and thence by telescopic shoot to the hold of the vessel lying alongside. When both silos are completed and at work it will be possible to take in grain from waggons at a maximum rate of 3,000 tons per hour, and to weigh and pass same either direct to vessel or to storage bins. Grain may also be discharged from the bins direct to vessel's hold at the rate of 3,000 tons per hour. Four vessels, one on each side of each silo building, can thus be loaded up at the same time in a very short period, and the quick discharge thus obtainable is now-a-days a matter of the highest importance.

In addition to the bin storage for grain in bulk there is floor storage provided in each building for about 5,000 tons of grain in sacks, and special appliances for elevating these sacks to any floor and for taking from any floor to vessel's hold have been provided. Special provision is also made for cleaning and for drying and conditioning grain when required.

The machinery throughout is driven

by electric motors, and a complete system of electric signalling and electric lighting plant has also been supplied by Messrs. Spencer & Co.

The whole of these buildings are constructed of steel and, with the machinery, were manufactured and temporarily erected at Messrs. Spencer's works at Melksham before being shipped to South America. The erection at Bahia Blanca was carried out entirely under the supervision of a number of Messrs. Spencer & Co.'s skilled erectors, under the charge of Mr. J. McEwan, a member of their staff.

The same firm also constructed for the Buenos Aires Great Southern Railway Co. two large floating elevators for loading up large steamers with grain in bulk from lighters. Fig. 3 gives a view of one of these at work in the port of Bahia Blanca.

## The "Allen" Vertical Oil Engine.

Oil engines of the vertical type have secured for themselves during the last few years a strong position. They offer many advantages over the older horizontal type as regards compactness, lightness and low running costs, and they are particularly suitable for direct coupling to dynamos and centrifugal pumps. One of the most prominent features of this class of engine is its low weight, and it is for this reason when combined with a centrifugal pump that it is so much used for irrigation work in countries where the cost of transport is excessive, and where the difficulty of conveyance makes it practically impossible for heavier machinery to be employed.

Messrs. W. H. Allen & Co., Ltd., Bedford, have recently introduced an engine of this type that has been designed to withstand rough usage, and is suitable for continuous running with the minimum amount of attention. It is totally enclosed, and splash lubrication is employed; the cam shaft, which is driven by spur wheels and carries the governor, being arranged inside the crank chamber. The trunk is a rigid box-form casting carrying the main bearings and cam shaft bearings, the bottom of this casting forming a well for the lubricating oil. A very simple form of splash guard is bolted inside the crank chamber to prevent excessive lubrication of the piston. As an extra precaution against over-lubrication in the larger engines, a ring is fitted near the bottom end of the piston; these arrangements are made to reduce the lubricating oil bill to a minimum.

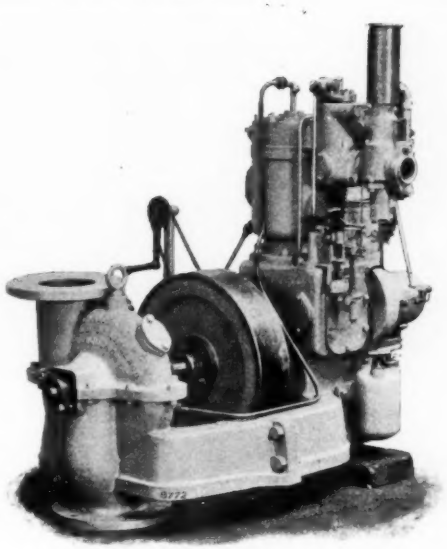

FIG. 4.—NEW VERTICAL OIL ENGINE BY MESSRS. W. H. ALLEN & CO., LTD., BEDFORD.

The vaporiser is heated for starting up with a small blow-lamp, but when the engine commences to work this lamp is extinguished, the vaporiser being maintained at a suitable temperature by the heat of the exhaust. It is designed in such a manner as to thoroughly evaporate the paraffin without overheating the air which is required to complete the charge. Perfect combustion is obtained with this vaporiser, which, it is stated, remains clean and free from any deposit after months of continuous working. The governor controls a balanced throttle valve placed close to the inlet valve.

Ignition is effected by a low-tension magneto, driven by special gear from the cam shaft. One hand-lever operates the retarded ignition and exhaust relief cam, for facilitating the starting up of the engine. Small brass plates indicate the starting and running positions of all levers, making it difficult for anyone to forget what to do when about to start up.

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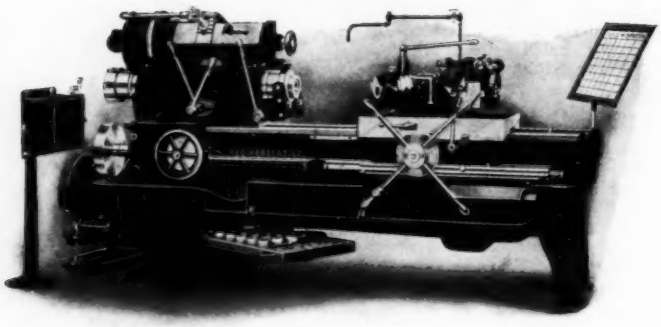

FIG. 5.—LATEST (1908) PATTERN HEXAGON TURRET LATHE. MESSRS. ALFRED HERBERT, LTD., COVENTRY.

## Turret Lathes for Bar-Work.

The hexagon turret lathe originated by Messrs. Alfred Herbert, Ltd., of Coventry, in 1898 was intended to produce direct from the bar articles such as spindles, shafts, screws, studs, lock-nuts, collars and similar work which forms an important part of the product of nearly all engineering establishments.

To handle this class of work in the best way it was necessary to design a machine which would deal with either long or short work, and which could be very quickly changed over so that it might be suitable for making either a large quantity or a few pieces at each setting of the tools.

Ever since its introduction this machine has been the firm's speciality. It has received a very considerable amount of attention, and as Messrs. Herbert themselves employ thirty of the machines in their own works, they have been able to watch their operation under ordinary workshop conditions, and frequent modifications in design have naturally resulted.

In its latest form the machine is built in three sizes, admitting bars up to $1\frac{1}{2}$ ins., $2\frac{1}{4}$ ins., and $3\frac{1}{2}$ ins., respectively, the 1908 pattern being shown in the medium size by Fig. 5.

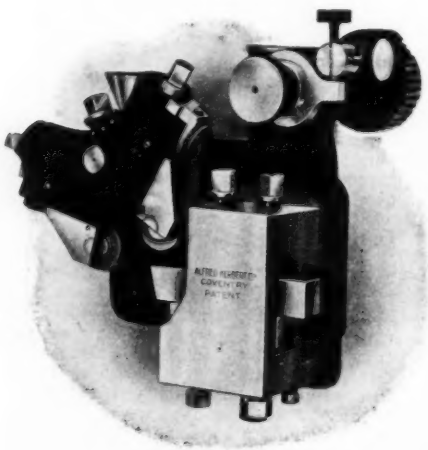

FIG. 6.—ROLLER STEADY TURNING TOOL.

It will be noticed that the headstock is of the all-geared type, the drive being through a large single pulley running at a constant speed, there being sixteen changes of speed to the spindle,—obtained mechanically in the headstock. This construction enables a constant belt velocity to be used to all spindle speeds and is particularly suited for direct electric driving. As shown in the illustration, the motor is placed on an adjustable base-plate on the floor, behind the machine and simply connected up with an endless belt. Any type or size of constant speed motor may be employed, no special work being required to either machine or motor.

The work is produced direct from the rough bar, which is carried through the hollow spindle and gripped by the automatic chuck. This latter may be opened and closed without stopping the machine and is provided with a complete set of jaws for holding round, square, or hexagon

bars of all sizes within the capacity of the machine. These jaws, together with the spare cutting tools and screwing dies supplied in the equipment, are all carried on the swinging tray seen attached to the cabinet under the fast headstock.

The turret, which is of hexagonal form, is hollow, allowing the finished work to pass through it, the overhang of the tools being consequently reduced to a minimum, and being constant for all lengths and diameters of work.

One of the special features of the lathe is its power of making any reduction in diameter at one cut, leaving a true, smooth, and parallel job.

The recently introduced roller steady turning tool is illustrated in Fig. 6. The cutter is carried in a steel holder which may be adjusted to and from the work for turning different diameters, and is provided with a very sensitive stop by means of which it may be returned to exactly the same position any number of times. The steadies, which take the pressure of the cut, consist of hardened tool steel rollers mounted on independent slides which can be quickly adjusted for various diameters, and are of such a form that the greater the pressure brought to bear upon them the more firmly are they kept in correct contact with the work, with the result that the latter is burnished. By the use of this tool, a 2 in. diameter bar of 30 ton steel may be reduced to 1 in. diameter at one cut at a feed of 6 in. per minute.

Screwing is performed by means of the "Coventry" self-opening diehead shown by Fig. 7, in which the dies are supported right up to their front edges and cannot cant under the pressure of the cut and produce imperfect work, and the method of manufacture is such as to give a keen cutting edge in front and a guiding portion, like a nut, further back, so that the dies always cut an accurate pitch. Further the method of manufacture enables one die of a set to be replaced, if broken.

The diehead opens automatically when the travel of the turret is retarded, either by hand or by an adjustable stop, and is further fitted with an attachment by means of which a light finishing cut may be taken of very coarse threads, or when screwing difficult material.

It is now generally admitted that this method of manufacture is cheaper than machining forgings between centres, and the increase in production that can be obtained by use of the roller steady tool above referred to has naturally enabled larger economies to be effected.

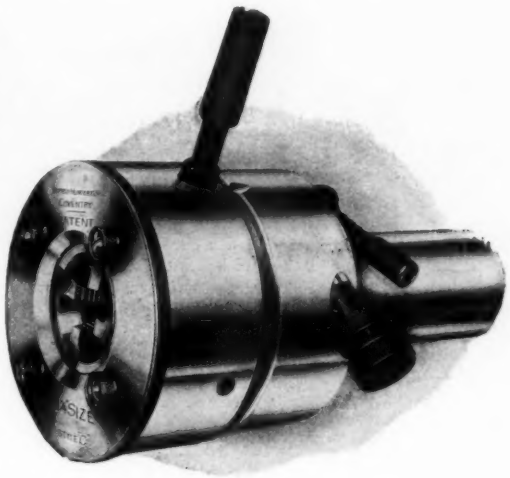

FIG. 7.—THE "COVENTRY" SELF-OPENING DIE HEAD.

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Messrs. Howard Bros., Proprietors and Manufacturers of the DEY TIME REGISTERS, 40, Paradise Street, Liverpool, and 100 B, Queen Victoria Street, London, E.C., notify that, for family reasons, their business will in future be carried on under the style of Dey Time Registers, Limited, under the same management as hithertofore. The London office and showrooms have been removed to more extensive premises at 75, Queen Victoria Street, E.C.

Messrs. Strachan and Henshaw, of Bristol, have now taken over the business of electric telpherage conveying plant previously handled by Messrs. Siemens Brothers Dynamo Works, Limited, London.

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TRANSLATIONS.—Extreme care has been taken with the translations of the Spanish Supplement, for which we are principally indebted to Mr. T. Demant, Northumberland Street, Newcastle-on-Tyne, and also to Señor A. Garcia. The Spanish matter has been carefully revised before going to press by Mr. H. H. Etheridge, Monte Caseros, Argentine Republic, an engineer resident in the Argentine.

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In this section is presented every month a list of the more important articles appearing in the Engineering Press and of the leading papers read before the various engineering institutions. Full names, addresses, and published prices of the publications indexed are printed each half-year in the volume index.

## Civil Engineering.

"Royal Edward" Dock at Avonmouth. Bristol. *Engineering*, 26*th June* and 3*rd July*, 1908; *Engineer*, 3*rd* and 10*th July*, 1908. *Railway Gazette*, 10*th July*, 1908.

Structural Steel Work. By E. G. Beck. *Mechanical World*, 3*rd July*, 1908.

Three Tramway Bridges on the Coal Storage Dock of the Berwind-White Coal Mining Co., Superior, Wis. *Engineering News*, 18*th June*, 1908.

The Design of Retaining Walls, II. *Engineering Record*, 20*th June*, 1908.

Rotherhithe Tunnel. *Railway Gazette*, 19*th June*, 1908.

## Building.

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A Theoretical Discussion of the Knee Brace Design of Wind Bracing in Steel Frame Buildings. By R. B. Wordsworth. *Proceedings Engineers' Society, Western Pennsylvania, June*, 1908.

Reinforced Concrete in Engineering Structures. By C. S. Melk. *Practical Engineer*, 26*th June*, 1908.

## Heating and Ventilation.

## Materials and Measurements.

On the determination of the Bending Moments at the Points of Support of Continuous Beams. By Prof. J. H. Smith, D.Sc. *Engineering*, 26*th June*, 1908.

Permeability Tests of Concrete with the addition of Hydraulic Lime. By S. E. Thompson, before the American Society Testing Materials. *Engineering Record*, 27*th June*, 1908.

Tests of Bond in Reinforced Concrete Beams. By M. O. Whitey, before American Society Testing Materials. *Engineering Record*, 27*th June*, 1908.

Methods for protecting Iron and Steel against Corrosion. *Journal Franklin Institute, June*, 1908.

A Summary of the Rules and Regulations, &c., for the use of Reinforced Concrete. By C. F. Marsh. *Concrete and Constructional Engineer, July*, 1908.

Notes on the Structure of a Brittle Sheet of a very Low Carbon Steel. By A. Sauveur. *Electrochemical and Metallurgical Industry, July*, 1908.

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Test of a Small Suction Gas Producer Plant. By Prof. H. B. MacFarland. *Journal Western Society Engineers, April*, 1908.

Some Results due to Improvement in Boiler and Furnace Design. By A. Bement. *Journal Western Society Engineers, April*, 1908.

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The Westinghouse Double-Flow Steam Turbine. *Machinery, June*, 1908.

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Practical Considerations of Thermal Efficiency of Petrol Engines. By T. A. B. *Practical Engineer*, 12*th June*, 1908.

Double-Deck Steam Turbine Power Plants. By J. R. Bibbins. *Proceedings American Institute Electrical Engineers, July*, 1908.

Compound Drop Valve Steam Engine. *Engineer*, 10*th July*, 1908.

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The Steam Consumption of Economical Steam Engines. *Practical Engineer*, 26*th June*, 1908.

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Dense-Air Winding Engines, VII. *Mechanical World*, 19*th June*, 1908.

## Hydraulics and Compressed Air.

Air Pumps and Condensers. By R. M. Ferguson. *Steamship*, *July*, 1908.

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How Weldless Chains are made. By Alex. G. Strathern. *Transactions Mining Institute, Scotland*, *April*, 1908.

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Automatic Signalling on the Metropolitan Railway. *Electrical Engineering, 11th June*, 1908.

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New Sewage Works at Twickenham, II. *Engineer*, 19*th June*, 1908.

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## Mining Exhibition at Olympia.

SPACE forbids us to do more than casually refer to this important exhibition that was held at Olympia during the past month. The fourth of a series organised by Mr. Greville Montgomery, M.P., previously held at the Agricultural Hall, Islington. it was by far the most representative, and although the bulk of the exhibits were related to coal mining machinery and plant, as, indeed, they should be, having regard to the extensive nature of the industry in Great Britain, metalliferous mining was also much in evidence.

In the galleries and the annexe some of the processes employed in coal, hydraulic and alluvial mining, and in diamond washing, were practically demonstrated, and it is to be regretted that features of such interest did not attract a larger public attendance.

Mining by machinery was the predominant feature of the exhibition, and forcibly demonstrated the supersession of hand labour by power processes with the proportionate saving of time and labour. The prominent part played by electricity to-day in mining operations was rendered strikingly apparent; and it would appear that, as time goes on, this form of energy will be even more thoroughly applied for cutting, hauling, hoisting, pumping and lighting.

Coal cutting machines of an improved type figured on the stands of the Belhaven Engineering & Motors, Ltd., who displayed an electrically-driven machine of the disc type; of Anderson Boyes & Co., Ltd., who showed longwall coal cutters of both chain and disc types, machines of the former class being also staged by Mavor & Coulson. The Hardy Patent Pick Co., Ltd., showed four compressed-air driven machines of various sizes for undercutting and shearing, and a puncher on a sledge for pillar and stall, and longwall work.

One of the novelties of the exhibition was on view at the stand of Hathorn & Co., in the shape of a new drill chuck embodying some important features. No bolts, nuts, wedges or pads are required with this apparatus, and the jumpers, which require no shanking, can be quickly changed, only one or two blows with a hammer being necessary. This firm also displayed a number of rock drills, which class of plant formed the main exhibit of the Tuckingmill Foundry Co., Ltd., Camborne. The Dunstan rock-drill bit-forging machine at the latter stand, already fully described and illustrated in THE ENGINEERING REVIEW, attracted much attention. The collection of exhibits of Messrs. Dick, Kerr & Co., Ltd., Preston, and of Messrs. Ernest Scott & Mountain, Ltd., Newcastle, formed a striking example of the application of electricity in mining operations. At the stand of the latter a 10 h.p. portable main rope haulage gear was shown with an 18 in. by 10 in. drum suitable for a rope speed

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of 4 m.p.h.; a three-throw horizontal mining pump mounted on wheels, and a vertical centrifugal pump—all electrically driven by motors of the firm's make. In the centrifugal pump the motor and pump are coupled together and arranged so that the delivery water from the pump passes through a liner round the motor, and through a breeches pipe on the top and into the rising main, supported on the breeches pipe. The whole weight of the rising main, pump, motor, water column, &c., are taken by wire ropes passing through pulleys on the side of the motor. Messrs. R. H. Longbotham & Co., Wakefield, showed as a principal exhibit a complete coal screening plant in motion. This has two through way revolving tipplers discharging on to two jigging screens, where the coal is screened into three sizes, the best coal being delivered straight on to two picking belts, the cobbles being deposited on to a cross tray conveyor, which in turn delivers from both screens on to one picking belt. The nuts and peas are discharged from each screen on to two vibratory screens, which sort out the peas, the latter falling through a shoot on to a cross belt conveyor, which takes this size coal direct to the washery, the nuts being delivered on to a fourth belt. The plant is worked with a 60 h.p. motor. A novel feature of this plant is the introduction of ferro-concrete as a flooring. A model of the "Ackroyd & Buckley" superheater was also to be seen on the stand. This is a new type of apparatus concerning which we shall have more to say in a later issue. It will suffice to mention here that it is constructed of steel boiler plates in the form of a chamber divided up into divisions by internal diaphragms, and takes the place of a back wall behind a Lancashire boiler.

The Hyatt Roller Bearing Co., Victoria Street, S.W., exhibited their well known flexible roller bearing for various purposes. One of the principal features of the exhibit was two standard mine tubs, one fitted with "Hyatt" bearings and the other fitted with the ordinary bearing, which is usually furnished with such tubs. Both cars were fully loaded, and the difference required to push these two cars was very marked.

The exhibits on the stand of Messrs. Stewarts & Lloyds, Ltd., comprised examples of wrought iron and steel tubes and connections, the chief of which for colliery use were those with loose flanges, for the conveyance of water, gas, and air, and wrought steel lap-welded pipes with solid welded connections for high pressure steam mains. Tubes for use in connection with boring, driving and lining of bore wells and conveying water and oil figured at the stand of John Russell & Co., Walsall.

Edgar Allen & Co., Ltd., Sheffield, had a fine display of their leading mining specialities, including a ball mill, stone breaker, automatic filler for bucket conveyors, and a number of manganese renewable parts. Another stand of equal interest from the metalliferous mining point of view was that of the Wilfley Mining Machinery Co., Salisbury House, E.C., who showed, amongst a varied range of plant, an ore concentrating table, slimer, crusher and crushing rolls, screens and differential jig. Compressed air plant was well represented by Reavell & Co., Ltd., Ipswich, who staged several types of their well-known electrically-driven compressors, including one adapted for use in-bye in collieries and a small sub-station cleaning set. Mention must be made of a novelty in the shape of an automatic pit-hill weighing machine by S. Denison & Sons, Ltd., Leeds. This records the weight of contents of each wagon and miner's number, printing all on a continuous tape. Another novelty was a new form of steam dryer shown at the stand of Princeps & Co., Sheffield. The steam is passed through the dryer in a spiral motion and, in its passage, is sheared by a series of grid plates which pass round the spiral. The water collected passes down each plate into a chamber at the bottom, which is not in contact with the passing steam. The apparatus is extremely simple in construction and well adapted for out-door use. Very much more could be written of an exhibition full of interesting features, but we must close this brief notice with a bare mention of such meritorious displays as those of the boiler mountings and stop valves of J. Hopkinson & Co., Ltd., Huddersfield, and Jenkins Bros., Ltd., Queen Victoria Street, E.C.; the winding and guide ropes and aerial ropeway plant of Bullivant & Co., Ltd., Mark Lane; mine ventilating and blast fans of Heenan & Froude, Ltd., Worcester; and the pipe and bolt screwing and tapping machines of Joshua Heap & Co., Ashton-under-Lyne. If not so imposing, none the less interesting were the stands of Joseph Wright & Co., Tipton; Gandy Belt Manufacturing Co., Ltd., Seacombe; Howard Bros. of "Dey" Time Register fame; E. Green & Son, Manchester; Fastnut, Ltd., London, E.C., the Eyre Smelting Co., Ltd., Tonbridge, and the Kennicott Water Softener Co., London, E.C.